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ORIGINAL ARTICLES.

I.—Notes on new or imperfectly known Chalk Polyzoa.

By R. M. Brydone, F.G.S.

(*Continued from the July Number, p. 296.*)

(PLATE XXII.)

Membranipora pyrigera, sp. nov. (Pl. XXII, Figs. 1–5.)

Zoarium always adherent, rarely large.

Zoœcia pyriform when not crowded, small, the earlier forms larger than the later, but individually very variable; area sub-triangular; a slight internal front wall, occasionally surrounded by a faint line; under the oœcia the rim is very thin, very low, and set distinctly back from the general curve.

Oœcia small, globose and prominent, the free edge coinciding very nearly but not quite accurately with the general curve of the margin of the area.

Avicularia short and pyriform, with a narrow oval aperture in the upper part deep-set within a short wide pyriform area, the sides of which near its lower end are folded over and inwards into hour-glass shape to a point which slightly overhangs the aperture; the rounded upper end of the area is also bent upwards and inwards into a hood shaped like a flat meniscus.

This species is one of the group of which *M. confluens*, Rss., is the best known. It seems to be easily distinguishable by its avicularia from any other described species. It is of regular occurrence throughout the zone of *A. quadratus* and in the lower part of the zone of *B. mucronata*; and the form of the zone of *M. cor-anguinum* illustrated by Fig. 4, and the form of the zone of *Marsupites* illustrated by Fig. 5, are probably stages in its development.

Membranipora tenebrosa, sp. nov. (Pl. XXII, Figs. 6–8.)

Zoarium always adherent; all my specimens are quite small.

Zoœcia very variable in size, more or less hexagonal, with a slight tendency towards being sub-pyriform; the area occupies the upper half and is circular or nearly so, and lies at the bottom of a slight circular depression, the rim of which is often marked by a faint line; a number of the zoœcia, varying according to the state of preservation and the care taken in cleaning, have smooth imperforate lids fitted to the rims of these depressions, often so closely that no suture can be detected, and the zoœcium appears to have a perfectly smooth and unbroken surface; the lids are generally convex, but are sometimes irregularly concave.

Oœcia helmet-shaped and small, rarely present, and when present fragile; the specimen with oœcia from which Fig. 7 is taken is quite exceptional.

Avicularia. None observed.

The circular area restricted to the upper half of the zoœcium distinguishes this species from any other of the lidded species yet described. It occurs sparingly in the zone of *A. quadratus*, the only zone from which I appear to have it.

MEMBRANIPORA PELLICULA, sp. nov. (Pl. XXII, Figs. 9–12.)

Zoarium always adherent, and so slightly raised as to be easily mistaken by the naked eye for a skin of dirt or chalk.

Zoœcia sub-pyriform to pyriform when not interfered with by other zoœcia, but often in crowded spots losing all trace of pyriformity and very variable in size; the area occupies normally about two-thirds of the length of the zoœcium and is a long narrow ellipse; it is often closed by a slightly convex lid in which there is a small elliptical pore of variable position.

Oœcia helmet-shaped, unusually long and distinctly squarish at the upper end.

Avicularia very numerous and very small, being narrow pyriform bodies with a smooth convex surface having a very narrow slit in its upper half, which is rather abruptly elevated above its lower half.

The extreme shallowness of the zoarium, the perforated lids, and the small and abundant avicularia form a combination which readily distinguishes this species from any other. It does not appear to occur below the subzone of *O. pilula*, in which it is very rare; but in the subzone of *A. quadratus* and the lower part of the zone of *B. mucronata* it occurs freely.

MEMBRANIPORA WITHERSI, sp. nov. (Pl. XXII, Fig. 13.)

Zoarium always adherent.

Zoœcia faintly sub-pyriform, and having a slight internal front wall, and tilted considerably, the head being much higher than the foot; the area is a straightish-sided ellipse about ·3 mm. long by ·2 mm. wide; on the zoœcial wall at the extreme head there is a pair of tiny projecting tubes; a little below them there is a pair of stout perforated spine bases with an imperforate pair some way below them; beneath the oœcia the zoœcial wall is very thin.

Oœcia widely helmet-shaped, distinctly large in proportion.

Avicularia of two kinds—one simple small pyriform bodies like those of *M. pellicula*, but having a much wider aperture, and tilted like the zoœcia; the other similar, but larger bodies lying horizontal and having also a terminal aperture formed by the upper end being sliced off by a downward and after a short way outward curving transverse cut along a line which falls just within the upper end of the horizontal aperture, so that the two apertures are just continuous.

At present I only know this species from the subzone of *A. quadratus*, in which it is not uncommon.

These four species illustrate well the gentle transition between normal *Membraniporæ* and the group which is generally assigned to

Pyripora and for which Canu[1] has proposed the genus *Pyriporella*. For my own part I find it so very difficult to draw any line between the two that I do not think it safe to treat them as generically distinct in the Chalk.

EXPLANATION OF PLATE XXII.

(All figures × 12 diams.)

Fig. 1.	*Membranipora pyrigera*.	Subzone of *A. quadratus* (I. of W.).	
,, 2.	,,	,, ,,	Portsdown, Hants.
,, 3.	,,	,, *O. pilula*,	West Meon, Hants.
,, 4.	,,	Zone of *M. cor-anguinum*,	Gravesend.
,, 5.	,,	,, *Marsupites*,	West Tisted, Hants.
,, 6.	*Membranipora tenebrosa*.	Subzone of *A. quadratus*,	Shawford, Hants.
,, 7.	,,	,, *E. scutatus*, var. *depressus*,	Newhaven.
,, 8.	,,	,, ,,	Ropley, Hants.
,, 9.	*Membranipora pellicula*.	,, *A. quadratus*,	Portsdown, Hants.
,, 10.	,,	,, ,,	Hensting, Hants.
,, 11.	,,	,, ,,	Portsdown, Hants.
,, 12.	,,	,, ,,	Hensting, Hants.
,, 13.	*Membranipora Withersi*.	,, ,,	Hensting, Hants.

II.—Carboniferous Zones Illustrated by Corals: an Exhibit at the Natural History Museum.

By W. D. Lang, M.A., F.G.S.

In view of the attention lately devoted by geological workers to the British Lower Carboniferous rocks and their fossils, an exhibit has been arranged in the Department of Geology at the Natural History Museum to illustrate the occurrence in the field of Corals in reference to the division of the Lower Carboniferous rocks into zones.

As is well known, Dr. A. Vaughan,[2] the pioneer of modern Lower Carboniferous stratigraphy, divided these rocks into five groups or zones, each named after the genus of Coral or Brachiopod dominant during the time that the zone bearing its name was deposited. A zone is thus seen to be all the material deposited during a given time. The time during which a zone was deposited has been termed by Buckman a 'hemera',[3] a term which has not come into common use, probably because it is as easy and more natural to say, for instance, 'in *Caninia* time' than 'in the hemera of *Caninia*'. It is true that the former might mean 'during the whole period during which *Caninia* existed', while 'hemera', as defined, is used for the time during which an organism was dominant; but in practice such confusion rarely occurs, and, until it is felt, the term 'hemera' is not likely to be generally used. Vaughan further divided his Carboniferous

[1] *Iconographie des Bry. Foss. de l'Argentine*, pt. ii, p. 234.

[2] Vaughan, "Palæontological Sequence in the Carboniferous Limestone of the Bristol Area": Quart. Journ. Geol. Soc., vol. lxi, pp. 181–307, 1905.

[3] Buckman, "The Bajocian of the Sherborne District," Quart. Journ. Geol. Soc., vol. xlix, p. 481, 1893. For a further explanation of the term, see the lucid and amusing article by Buckman, "The term Hemera," Geol. Mag., Dec. IV, Vol. IX, pp. 554–7, 1902, followed by correspondence in Geol. Mag., Dec. IV, Vol. X, 1903. The zone also is discussed in these papers.

zones into sub-zones named after species of Corals, Brachiopods, and, in one instance, a Lamellibranch Mollusc.

Now all Vaughan's zones except two are named after Coral genera; and for these dissenting zones there are corresponding Coral equivalents, since the hemera of *Lithostrotion* nearly coincided with that of the Brachiopod *Seminula*, and the hemera of the Coral *Caninia* with that of *Syringothyris*. Again, the only sub-zones named after Corals are the two subdivisions of the topmost zone. It is possible, then, with the Corals used by Vaughan as the indices of his zones and sub-zones to make six consecutive divisions of the Lower Carboniferous rocks. The main part of the exhibit demonstrates these six subdivisions, namely, from below upwards, the zones of *Cleistopora*, *Zaphrentis*, *Caninia*, *Lithostrotion*, and the sub-zones of *Dibunophyllum* 0 and *Lonsdalia floriformis* of the *Dibunophyllum* zone, each with its distinctive letter for abbreviated reference, K, Z, C, S, D_1, and D_2; and gives examples of the Corals after which the zones are named, with, in some instances, another species found with the zonal Coral, and diagrams showing the zonal Corals' structure.

Since it was in the gorge of the River Avon at Bristol that Vaughan founded these subdivisions of Lower Carboniferous rocks, photographs of this typical section have been placed at the sides of the case, and alongside them diagrams showing the limits of the zones traversed as the right bank of the Avon is followed from north to south.[1]

It is to be expected in most cases where stratigraphical divisions are founded upon a single dominant species or genus that it will be possible to apply the same divisions to other areas with a strictness that is only inversely proportional to the distance traversed. Thus Vaughan's zones, though found to hold good in the main, require some modification where the Lower Carboniferous rocks of other areas in the British Isles have been examined.[2] It is not at present possible to show these modifications, and this exhibit is confined to the zones of the typical area which has served as a basis for subsequent work.

Two other points need emphasis in connexion with Vaughan's zones. The difference between the time during which a species existed and its hemera has already been noted. Again, the sequence of zones does not necessarily imply a phylogenetic series.[3] Thus, while *Caninia* is almost certainly a direct derivative of *Zaphrentis*, it probably does not lead on to *Dibunophyllum*; and *Cleistopora*, even if a Coral, is certainly not a radical of the Rugose genera of the higher zones. It is thought that there was much migration of Coral

[1] Professor S. H. Reynolds kindly lent his negatives of the photographs published in Vaughan's paper, "The Carboniferous Limestone Series (Avonian) of the Avon Gorge," Proc. Brist. Nat. Soc., ser. IV, vol. i, pt. ii, pp. 74–168, 1906, from which the exhibited photographs were printed.

[2] e.g. in North-West Ireland, see "The Lower Carboniferous Succession at Bundoran in South Donegal" in *The Geology of Parts of North-Western Ireland*, issued by the Geologists' Association for the August excursion, 1912, p. 9.

[3] See Carruthers, "On Coral Zones in the Carboniferous Limestone": GEOL. MAG., Dec. V, Vol. VII, p. 172, 1910.

stocks[1] from area to area, and thus in a given district one stock supplanted another, causing either its extinction or its migration elsewhere.

Vaughan's work, starting with frankly stratigraphic aims, has given stimulus to purely palæontological work which promises to revolutionize the present knowledge of Palæozoic Corals. Though good work has been already done, notably by Carruthers,[2] the field is too vast for generalizations yet to have been established. But a few points in fossil Coral work seem to become increasingly clear. (1) The lack of knowledge as to what characters are directly the result of environment and what directly due to heredity. (2) Our ignorance of the bionomic significance of Coral skeletal structures. (3) The independent acquisition of similar structures in Corals of presumably different ancestry (e.g. the 'central area' of various unrelated genera formerly grouped as Clisiophyllids). (4) The importance of the earliest stages of the Coral skeleton. From these follow (5) the futility of a description and figure of a simple Coral giving a transverse section at one level only; serial sections (the more the better) are absolutely necessary for descriptive purposes; and (6) the necessity of the means of cutting any required number of serial sections in studying any species.

The above results may be thought discouraging, and our ignorance under the old, if artificial, classification, bliss. But advances in knowledge are bound to be superficially destructive, and already some constructive work has been done. It is hoped that some results will shortly be shown in the remaining side of the zonal exhibit case. Meanwhile laborious work alone can wrest from the Corals the story of their evolution.

III.—The Uppermost Silurian and Old Red Sandstone of South Staffordshire.

By W. Wickham King, F.G.S., and W. J. Lewis, B.Sc.

IN the core of the Netherton Anticline at Saltwells, near Dudley, in the vicinity of a small area of basalt marked on the Geological Survey maps, Mr. King, in February last, discovered a series of rocks, ranging from the Upper Ludlow Mudstones to the Old Red Sandstone, cropping out from beneath the base of the Coal-measures of South Staffordshire. During April Mr. Lewis independently recognized Silurian here, and we agreed to work out the details together.

[1] e.g. the case recorded in "The Lower Carboniferous Succession at Bundoran in South Donegal" in *The Geology of Parts of North-Western Ireland*, issued by the Geologists' Association for the August excursion, 1912, p. 14.

[2] Carruthers, "The Primary Septal Plan of the Rugosa," Ann. Mag. Nat. Hist., ser. VII, vol. xviii, pp. 356–63, 1906; "A Revision of some Carboniferous Corals," Geol. Mag., Dec. V, Vol. V, pp. 20, 63, and 158, 1908; "The Evolution of *Zaphrentis delanouei* in Lower Carboniferous Times." Quart. Journ. Geol. Soc., vol. lxvi, pp. 523–38, 1910. Of other authors' publications, the most important is that by Salée, "Le Genre *Caninia*," Mémoire couronné au Concours interuniversitaire des Sciences minérales de 1910, publié sous les auspices du Ministère des Sciences et des Arts, Bruxelles, 1910.

Mr. J. Beete Jukes, in 1859, thought that the Old Red Sandstone, Carboniferous Limestone, and Millstone Grit were not laid down in South Staffordshire.[1] It is, however, within the knowledge of one of us that he was afterwards shown, in 1866 or 1867, some rocks like Old Red Sandstone, and a limestone containing *Pterygotus* and *Lingula cornea* (?), found beneath the Coal-measures of South Staffordshire, at the bottom of the Wassell Grove Pits, Hagley, 3 miles south of Saltwells.[2] Afterwards at the Manor Pit,

FIG. 1. Map of area referred to in this paper. Scale = 3 miles to 1 inch.

[1] *South Staffs. Coal-field*, 2nd ed., pp. xii, 134 (Mem. Geol. Surv.). Since then Carboniferous Limestone and Millstone Grit have been found underground at the northern end of the coal-field (Q.J.G.S., vol. lxii, p. 523, 1906, and Trans. of North Staffs. Club, 1903–4, p. 123; cf. Q.J.G.S., vol. lv, pp. 126–7, 1899.

[2] *Dudley Guardian* of June 22, 1867. Mr. King has found on this pit mound pieces of the Temeside Bone-bed with *L. cornea*, *Onchus*, and Eurypteridæ, green shales covered with black markings of Eurypteridæ, and red and purple micaceous sandstones.

Halesowen, 4 miles south-east of Saltwells, the Ledbury Passage or Temeside Beds were pierced, containing *Lingula cornea* and *Cephalaspis Murchisoni*, etc.[1] Mr. Jukes[2] had, however, already recorded red beds at the Level Colliery[3] and at the Leys Colliery, Brierley Hill, at 290 and 120 feet below the Thick Coal, and Salt Water at Corbyns Hall, and Shut End, Kingswinford, at 172 and 111 feet below the Thick Coal. He pointed out the possibility of Old Red Sandstone forming the floor of the coal-field at the Level and Leys Collieries. Kingswinford is 2½ miles to north-west, and the Leys Pits 2 miles west, and the Level Pit only a quarter of a mile west of Saltwells. These localities are shown on Map, Fig. 1. In 1878 Mr. George Jones contented himself with the record that 'Silurian Beds' were exposed at Netherton.[4]

The uppermost Silurian and Lower Old Red Sandstones of Saltwells are exposed in the northern part of the Netherton Anticline in an area, 400 yards or less in width from east to west, and 1 mile long from north to south, commencing close to Brewins Tunnel and ending at a point near to Saltwells Inn. Two miles south of Saltwells Inn the Silurian again emerges at the Hayes, near the Lye, within an area 100 yards from east to west and 300 yards from north to south. The strike of the rocks is in both areas partly S.S.W. to N.N.E. and partly S.S.E. to N.N.W. W.S.W. to E.N.E. faults cross the anticline both at Saltwells and the Hayes. The Aymestry and Upper Ludlow Groups also occur at Sedgley, 4 miles to N.N.W. of, and at Turner's Hill, 3 miles to north-west of Saltwells. The four areas are shown on the Map, Fig. 1.

We have endeavoured to arrange the uppermost Silurian of South Staffordshire in the same way as that at Ludlow, so carefully classified by Miss Elles and Miss Slater.[5] In South Staffordshire we cannot identify some of their zones, and certain fossils reach higher horizons than at Ludlow.

Their main divisions were as follows:—

Temeside Group.	F.	Temeside shales with Bone-beds F^b and F^d and grits.
	E.	Downton Castle Sandstones with the *Platyschisma* bed (E^b).
Upper Ludlow Group	D.	*Chonetes* flags with Ludlow Bone-bed (D^e).
	C.	*Rhynchonella* flags.
Aymestry Group	B.	*Dayia* Shales.
	A.	*Conchidium* limestone.

Description of the Beds.

1. *The Aymestry and Upper Ludlow Groups.*—These, in their entirety, are exposed at the Hayes, dipping 40° east where the main road from Stourbridge to Halesowen passes in a cutting across the Netherton Anticline.

[1] Proc. Birmingham Phil. Soc., vol. v, p. 138. The specimens are at the University Museum, Birmingham.
[2] *South Staffs. Coal-field*, 2nd ed., pp. 81, 82.
[3] Cf. *Silurian System*, 1839, p. 478.
[4] Proc. Dudley Geol. Soc., vol. iv, p. 17, 1878.
[5] Q.J.G.S., vol. lxii, p. 195, 1906.

Sir R. Murchison[1] recorded here the Lower Ludlow, and the best sequence in South Staffordshire of the Upper Ludlow. Neither he nor any other writer has been able to announce the thickness of these beds.

The Lower Ludlow is seen underlying the Aymestry Limestone, on the western side of the anticline, north of the main road, by the side of a wall on the east side of a newly erected house.

The succession is thus:—

		ft.	in.
A.[2]	Aymestry Massive Limestone with *Conchidium Knightii*, *Atrypa reticularis*, *Euomphalus alatus*, *Lituites Ibex*, *Strophomena rhomboidalis* and *ornatella*, *Pentamerus galeatus*, etc. . .	4	6
	Nodular limestones with thin blue partings. *Atrypa reticularis* (common), *Encrinurus punctatus*, *O. lunata*, *R. nucula*. (At Sedgley *Conchidium Knightii* occurs in these nodular limestones.)	7	0
B, C.	Limestones with thin blue partings. *Dayia navicula* and *R. nucula* (abundant), *Chonetes minima*, *O. canaliculata* .	8	0
	Limestones (collectively 28 inches) with yellowish-brown partings. *R. nucula* and *Wilsoni*, *O. lunata* . . .	7	0
D.	Calcareous yellowish-green sandstones with thin limestone bands. The latter aggregate 3 feet and some are nodular. *O. lunata*, *Chonetes striatella* (common), *R. nucula* (common), *R. Wilsoni*	12	0
	Calcareous green sandstones	5	0
	Nodular limestones (collectively 4 feet) and calcareous green sandstones	7	0
	Yellowish-green calcareous sandstones which in the upper layers are full of bones	14	6
D^c.	Ludlow Bone-bed with *R. nucula*, *Onchus*, *Thelodus*, *Bellerophon globatus*, *Lingula Lewisii* (medium species), and bones .		6
	Total thickness of Aymestry and Upper Ludlow Groups . .	65	6

In all D (except D^c) *Chonetes striatella* and *minima* and *R. nucula* are very common. The section continues without interruption with Downton Sandstones (E^a), thus:—

	ft.	in.
Greenish-yellow gritty shale. (Fish?) spines and black markings	3	3
Hard yellow sandstones with two partings of 6″ and 16″, *Lingula Lewisii* (medium species), and black markings	10	6
	13	9

A large building covers the ground to the east.

We have checked Mr. King's measurements at the Hayes with the beds A, B, C, and D exposed at Sedgley, which were described as Aymestry and Upper Ludlow by Sir R. Murchison and Mr. Jukes.

In the quarries 400 yards and upwards W.N.W. of the Beacon Tower, Sedgley, the Lower Ludlow is exposed with 40 feet of the Aymestry and Upper Ludlow Groups above it. The highest beds

[1] *Silurian System*, 1839, p. 483.

[2] The letters we use are the same as in Q.J.G.S., vol. lxii, p. 195, 1906.

(14 feet) are Upper Ludlow yellowish-green mudstones (D) with many *Chonetes striatella*. This leaves 26 feet for A, B, and C.

The sequence at the first quarry north of Sedgley Church, which we have compared with the Beacon Hill Quarry, is thus :—

		ft.	in.
A.	Aymestry massive limestone with *Conchidium Knightii* . .	6	6
	Nodular limestones with thin blue partings. *Atrypa reticularis*, *R. nucula* (very common), *R. Wilsoni*, *Pentamerus galeatus*, *Conchidium Knightii* (1 foot above massive limestone), *Strophomena rhomboidalis*, *O. canaliculata*, *Chonetes striatella* and *minima* (rare)	5	0
B, C.	Limestones with thin blue partings. *R. nucula* and *Wilsoni* (very common), *O. canaliculata* and *lunata*, *Orbiculoidea rugata*, *Dayia navicula* (common), *Serpulites longissimus* .	4	6
	Limestones with some blue partings at base and thick brown partings higher up. *Rhynchonella nucula* (very common), *O. canaliculata*, *lunata*, and *elegantula*, *Chonetes striatella*, *Orbiculoidea rugata*, *Dayia navicula*, *Cardiola interrupta*, *Orthonata amygdalina*	4	6
	Limestones and brown calcareous sandstones. *R. nucula*, *Chonetes striatella* and *minima* (all common), *O. canaliculata*, *lunata*, and *elegantula*, *R. Wilsoni*, *Lingula lata*, *Cyclonema coralii*	5	6
D.	Calcareous yellowish-green sandstones with thin 2–3 in. limestone bands. *R. nucula*, *Chonetes striatella* and *minima* (all abundant), *R. Wilsoni*, etc.	9	0
		35	0

In all the Sedgley quarries where the massive limestone occurs we find, if the section continues upwards for 25 feet, that *Chonetes striatella* and *minima* abound and *L. lata* occurs. The Aymestry and Upper Ludlow strata below this *Chonetes* zone, both at the Lye and at Sedgley, are lithologically similar, and are in thickness always under 30 feet.

Though the Ludlow Bone-bed cannot so far be found at Sedgley, yet we detected it 1 mile to the S.S.W. at Turner's Hill in an overgrown quarry at the top of the hill and in the adjacent footpath. Murchison recorded limestones and dirty yellowish sandstones of Ludlow age here.[1] The lowest bed in this upper quarry is a peculiar reddish-brown sandstone (D^b) with *R. nucula* and *Chonetes minima* that at Saltwells is within $5\frac{1}{2}$ feet of the bone-bed. Above this are hard quartzitic and fine yellow sandstones. The fine yellow sandstones are similar to the less calcareous parts of the rocks which at Saltwells are interstratified in the two bone-beds' impure limestones, and at Lye occur just above and below the Ludlow Bone-bed. Both these sandstones contain many *L. Lewisii* (medium species) and the yellow sandstones *Onchus* and *R. nucula* and black markings in abundance. They are succeeded by coarser yellow sandstones, like E^a at Lye, with *L. Lewisii*. Coal-measure clays overlie the latter. We have found in the quarry at the bottom of the hill *Strophomena euglypha*, *rhomboidalis*, *ornatella*, *Atrypa reticularis*, etc., and identify the rocks exposed there as belonging to Zone A,

[1] *Silurian System*, 1839, p. 482.

with Lower Ludlow Shales below. The area is much faulted, hiding part of the Upper Ludlow.

At Saltwells (Fig. 2) less than 20 feet of the Upper Ludlow is exposed north and south of the bridge over Messrs. Doulton's tramway.

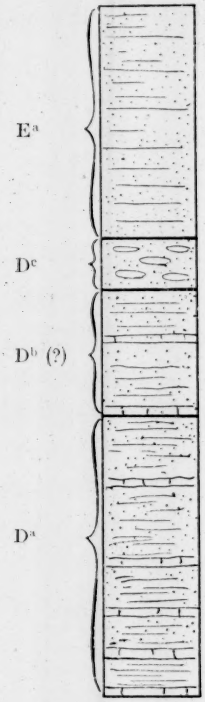

FIG. 2. Section north and south of Tram Bridge, Saltwells. Scale 8 feet = 1 inch.

The lowest beds (D) are calcareous green sandstones, with thin bands of limestone near the base. They are crowded, especially in the limestone bands, with *Chonetes striatella* and *minima* and—*R. nucula*. *L. lata*, *Holopella obsoleta*, *Orbiculoidea rugata*, *Serpulites longissimus*, *Cornulites serpularis*, etc., also occur.

For 5½ feet below the Ludlow Bone-bed occur shales, calcareous sandstones, and flags, with a more calcareous sandstone at the base, which is lithologically like a zone of D^b at Downton Castle Bridge, namely, a white calcareous sandstone in the centre which weathers to a peculiar and distinctive reddish-brown sandstone, with *Chonetes striatella* and *minima*, *R. nucula* (all very common), *Orthonota semisulcata*, etc.

The Bone-bed (D^c) varies from being 23 inches thick, most of which is an impure limestone, to Bone-bed 4 inches, calcareous sandstone full of black material 9½ inches, Bone-bed 1½ inches.

It contains *Chonetes striatella*, *O. elegantula*, *R. nucula*, *Lingula* sp. (?), fragments of fish scales and bones, *Onchus*, *Thelodus*, *Holopella obsoleta*, *Pachytheca*.

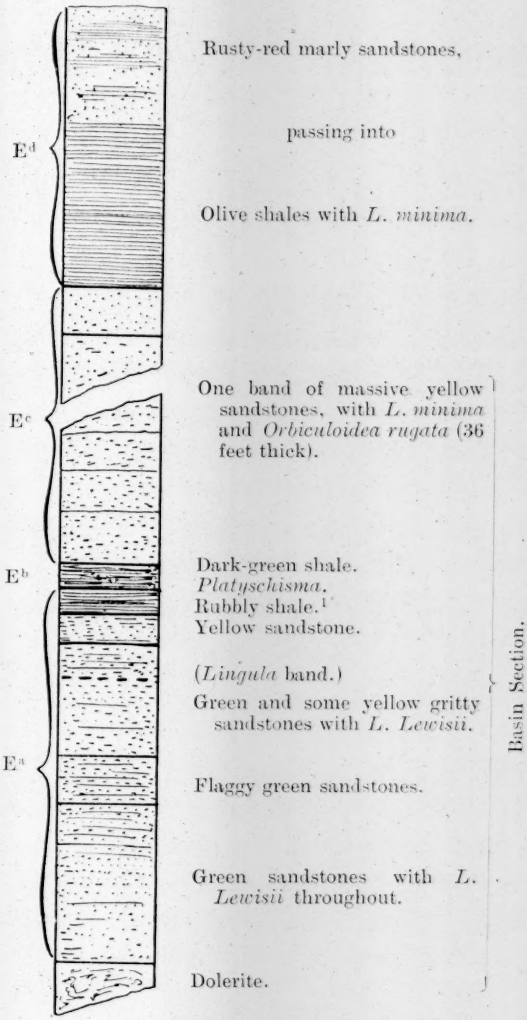

FIG. 3. Section of Downton Sandstones in the lower part of Brewins Tunnel and at the "Basin Section". Scale 8 feet = 1 inch.

[1] This is the lowest bed seen on south side of Brewins Tunnel.

(To be concluded in our next Number.)

IV.—On the Discovery of Remains of *Iguanodon mantelli* in the Wealden Beds of Brighstone Bay, Isle of Wight.

By Reginald W. Hooley, F.G.S.

THE *Iguanodon*, as is well known, was discovered by Mantell, who in 1825 named it from odd teeth which had a resemblance to the teeth of the recent *Iguana*. Many isolated teeth and bones were subsequently found in the Wealden and Lower Greensand beds to which the names of *I. anglicum* (F. Holl, 1829) and *I. mantelli* (H. von Meyer, 1832) were given. It was not, however, until 1851, when Owen described an associated group of bones on a slab of sandstone from the Kentish Rag (Hythe Beds, Lower Greensand) of Maidstone, Kent, which had been discovered by W. H. Bensted in 1834, that the genus was to any extent known. This specimen has become the type of *I. mantelli*. In 1878 occurred the historic discovery of the skeletons of a number of *Iguanodons* in the Wealden beds of Bernissart, near Mons, Belgium.

Among these, two forms were found, a small and a large. The former was identified as *I. mantelli* and the latter as a new species. These conclusions have been generally accepted by palæontologists, but the question is reopened by the discovery of the specimen now to be described.

Description of the Specimen.—In September, 1899, while searching the cliff about 150 yards west of Cowlease Chine, Isle of Wight, I discovered several pieces of bone in the debris caused by a fall in the cliff. On examining that part of the cliff from which it had been displaced I found many bones in situ. They were lying 8 feet above the *Hypsilophodon* Bed near the base of the 19 feet of blue shales, with *Unio* and *Paludina* in the top and *Cyrena* and *Paludina* at the bottom, as mentioned in the section given in the Geological Survey Memoirs of the Isle of Wight, 1889, p. 15. On carefully removing the shale, a series of eight caudal vertebræ was found lying in connexion and entire, with the exception of two neural spines. In addition there were, anterior to these, and consecutive, two neural and one hæmal spines. The combined length of the neural spine centrum and chevron of the most anterior vertebræ (? the twelfth caudal) was 990 mm., and covered a space 863 mm. wide. On removing the vertebræ and clearing away the matrix I found a fine pubic bone, perfect except the post-acetabular process, which had been broken off in the fall of the mass. Amongst the debris many portions of bone more or less fragmentary were obtained. Many of these I have been able to put together, the result being the centra of four caudal vertebræ, five neurapophyses and two hæmapophyses of caudal vertebræ, the left ilium minus the pre-post-acetabular processes, portions of the right ilium and pubic bones, the sacrum, two lumbar vertebræ, and the posterior moiety of a third.

Portions of the neural spines of the last four sacral vertebræ were preserved. The penultimate and ultimate transverse processes of the right side are intact, and the bases of the remaining three. On the left side there is the full series of five, nearly perfect. This

section of the cliff was watched at brief intervals, and from a small slip at the same spot a left femur was obtained.

The bone was broken in its fall. The upper and median trochanter and the posterior moiety of the inner condyle were destroyed. The distal end had been much damaged while in a soft condition, the outer condyle being completely doubled back and the preserved portion of the inner condyle twisted round some distance anterior to its true position. Later, from the same place were obtained the right and left ischium. The former is perfect, but the latter has lost about 10 mm. of the anterior acetabular portion, the obturator process is bent out of position, and the shaft of the bone has been broken, slightly twisted (not the natural twist) and cemented in that position.

The caudal vertebræ found in situ were lying at right angles to the face of the cliff, the posterior being innermost. Although many rolled and odd bones and teeth have been found, the present is the largest number of associated remains of *Iguanodon* yet found in the Isle of Wight.

The Sacrum.—The sacrum possesses five vertebræ. The centra of two anterior vertebræ are anchylosed to these, but the neural spines and arches are lost. These two centra exhibit on the right side wing-like processes placed vertically. The transverse sacral ribs spring from the neural arches as bars of bone, and continue thus to their extremities. The three posterior are fused throughout their length to a plate of bone. This plate between the second and third ribs passes inwards and unites with the centrum beneath the first sacral rib. This rib and the second, for the greater part of their length, are free from the plate and rise well above it. The exterior lateral border of the plate forms a deep upright wall. On a ventral view, this plate is roughly shield-shaped, and the width across the shoulder, which is situated under the third rib, nearly equals the length of its sides. These sides have a slightly concave outline. The posterior border is straight.

There are four sacral foramina.

The Ilium.—The form of that portion of the ilium preserved is close to that figured by Professor L. Dollo,[1] and as the other bones are identical, there cannot be any doubt that the forms of the missing pre-post-acetabular extremities were similar.

The Pubic Bone.—The pubic bone is a remarkably thin plate, the width at the anterior end being one-seventeenth of the depth. It is moderately thick near the acetabular margin, but considerably increases superiorly for union with the ilium. The anterior third of the bone is expanded into a broad circular plate, which is more than half as deep as in the median region of the shaft. This disc-like extremity is quite different from the spatulate form of that of *I. bernissartensis*.

The Ischium.—The ischium is hammer-headed in form; its preaxial end is not nearly as robust as the postaxial, which is much thickened

[1] L. Dollo, "Première Note sur les Dinosauriens": Bull. Mus. R. Hist. Nat. Belg., vol. i, pl. ix, fig. 1.

for articulation with the ilium. The area between these extremities and the obturator process is basin-shaped. The obturator process is strongly developed and produced some distance from the shaft. The extremity is expanded and curved. The postaxial border of the whole bone is thicker than the preaxial, which is compressed into a thin edge. The shaft is twisted so that the preaxial margin becomes ventrally postaxial. The ventral extremity of the shaft is expanded pre-postaxially.

Determination of the Specimen.—These remains belonged to an individual exceeding the dimensions of *I. bernissartensis*, which would appear to preclude their identification with *I. mantelli*, for all the bones of the latter found either in England or at Bernissart have been nearly equal in size and much smaller and more graceful than those of *I. bernissartensis*. But the characters of the bones now being considered are identical with those which have been ascertained from the type fossil from Maidstone and the specimen of Bernissart, and leave no doubt that they are one and the same species. These characters are the presence of five vertebræ in the sacrum, the form of the pre-acetabular portion of the pubis, and the position of the median trochanter in the middle third of the shaft of the femur. The figure of the pelvic bones and femur of *I. mantelli* given by Professor L. Dollo[1] admirably represents the bones under review, and consequently they differ from the figure (fig. 4) of the same bones of *I. bernissartensis* given on the same plate. I was surprised to find that no detailed description and measurements of the sacrum and bones of the pelvis or illustration of the sacrum of either of the *Iguanodons* of Bernissart had been published, and I recently wrote to Professor L. Dollo, who informed me that he was at the present time engaged on a monograph in which they would appear, and also that in reality there is only one specimen that belongs with certainty to *I. mantelli* in the collection of Bernissart against more than twenty of *I. bernissartensis*.

Sundry measurements have been given, and before discussing the questions arising from their great dimensions it will be well to compare them with those of the present specimen.

The length of the pubic bone from the axis of the acetabulum in the several specimens is—

	I. mantelli.	*I. bernissartensis.*
	mm.	mm.
Bernissart example[2] . .	400	700
Atherfield example . .	720	
The length of the femur—		
Bernissart examples[2] . .	710	1080[3]
London (type-specimen)[2] . .	810	
Atherfield example . .	1158	

These figures prove a specimen of *I. mantelli* even greater in size than *I. bernissartensis*, and the lightness, gracefulness, and smallness

[1] L. Dollo, "Première Note sur les Dinosauriens": Bull. Mus. R. Hist. Nat. Belg., vol. i, pl. ix, fig. 1.

[2] Loc. cit., p. 164.

[3] R. Lydekker, B.M. Cat. Foss. Rep. Amp., 1888, pt. i, p. 202.

of skeleton can no longer be used as characters separating the two species. Thus it becomes a moot point whether the differences to be found in the skeletons of the two forms are not after all sexual, for the type is too marked to be a case of individual peculiarities and the divergent characters do not seem sufficiently great to be of specific value.

Mr. G. A. Boulenger[1] thought that the presence of six vertebræ in the sacrum of *I. bernissartensis* and five in that of *I. mantelli* proved the former a different species from the latter, but M. P. J. Van Beneden[1] held that the variation in the number was only due to individual differences, and that the number varied in Dinosaurs from four to six. Professor L. Dollo[1] later strongly supported the conclusions of Mr. G. A. Boulenger, considering that the obliteration of the cranial sutures and of the neuro-central suture of the vertebræ and the presence of a foramen in the coracoid of the small form, which had obviously communicated during youth with the exterior, excluded the idea of making them young individuals, and that therefore the large form could not thus represent the adult state of the small. Neither did he think that the divergences could be explained by individual variations, and although the smaller size, greater gracefulness, and the reduction of the thumb might be interpreted as sexual variations, the different form of the pelvis and the number of the sacral vertebræ would not admit of this interpretation. Therefore he concluded that individual variations and sexual characters were insufficient to explain the two forms.

With regard to the specimen of the sacrum in the British Museum, No. 37685, Hulke[2] many years ago doubted its belonging to *I. mantelli*, and after an examination of it I am convinced that he is correct.

The presence of only five sacral vertebræ in the form known as *I. mantelli* may possibly be connected with the situation of the median trochanter in the middle third of the shaft of the femur. Such a position by curtailing the length of the caudo-femoral muscle would not allow so great a stride as in *I. bernissartensis*, where it is placed in the lower third. The swaying of the ponderous tail would be less, and consequently there would be a decreased strain on the sacral vertebræ. In *I. bernissartensis* the greater stride and probably increased activity necessitated more rigidity in the sacral region, the result being six instead of five sacral vertebræ in that form. Moreover, I suggest that *I. mantelli* was the female and *I. bernissartensis* the male of the same species, and that this Dinosaur was viviparous. There is evidence that some were, for Marsh[3] declares that there is an embryo within the ribs of the type-specimen of *Compsognathus*, and it is a well-known fact that among the Ichthyopterygia, *Ichthyosaurus* was. If this were the case in *Iguanodon*, the differences found in the sacrum, pelvis, and femur need no further explanation. The expanded preacetabular extremity of the pubic bone into a large circular plate in *I. mantelli* is strikingly different from the spatulate form of *I. bernissartensis*. Is it not possible that

[1] *Vide supra*.
[2] J. W. Hulke, Quart. Journ. Geol. Soc., vol. xxxvi, p. 447, 1880.
[3] Marsh, *Amer. Journ. Sci.*, ser. III, vol. xxii, p. 340.

this expansion was an adaptation for the express purpose of insuring protection and support for the embryo? During the swing of the tail from side to side the body must have swayed in unison, and without a stiff lateral stop the embryo would have been compressed and distorted by constant thrust against the walls of the abdomen, so that injury would have occurred.

There was no symphysial union of the pubes and ischia, and the pubic bone has in all the Orthopoda a decided deepening at some portion of its length and is directed more forward than downward. The inner trochanter of the femur of *Iguanodon* is so much more developed than in other genera that the vertical expansion of the pubis would seem to have a relation to the swaying of the viscera caused by the peculiar bipedal progression of the reptile.

In the Theropoda the median symphysial union of the pubes and its prolongation along the lower anterior border formed, together with the fused ischia, a cradle for the embryo, so that an expansion of the pubic bone was not necessary.

Moreover, the position near the proximal end of the femur and weakness of the inner trochanter seem to show that in these reptiles the waddling was not nearly so great as in *Iguanodon*, and it is a question whether the Theropoda were really habitually bipeds. In the Sauropoda we find the same cradle-like pelvis, which would be more suitable for the protection of the embryo and for quadrupedal habits.

If *I. mantelli* is the female of *I. bernissartensis*, then the extent of the nares and the length of the tibia are features which are due to sexual divergence. In regard to the strange circumstance that at Bernissart the small form was found apart from the large forms, it does not seem a more remarkable coincidence than that every specimen of *I. mantelli* found up to the present has been smaller than *I. bernissartensis*.

Therefore the conclusion appears reasonable that the osteological variations are sexual and that *I. bernissartensis* is a synonym of *I. mantelli*.

In conclusion, the evidence seems to prove—

1. That *I. mantelli* attained the dimensions of *I. bernissartensis*.
2. That the differences found in the forms of the pelvic bones is probably sexual, an adaptation for the preservation of the embryo.
3. That *I. bernissartensis* is a synonym of *I. mantelli*.
4. That not only the body of the *Iguanodon* (as shown by Professor L. Dollo) is a lever of the first kind, but the bones of the pelvis comprise one also.
5. That the ventral expansion of the pubes and ischia was to give greater leverage power.
6. That the direction and ventral separation of the pubes and ischia were adapted for the sagging of the visceral mass when adopting the erect attitude.
7. That the prolongation and the recurving of the ischia were for the support of that mass when in that position.
8. That in the Theropoda, Orthopoda (sections *Stegosauria* and *Ceratopsia*) the upright position was seldom assumed.

9. That only in the Orthopoda high specialization of the pelvis had been obtained.

10. That the pelvis of *Triceratops* and *Stegosauria* show an incipient stage towards bipedal progression and not a secondary return to quadrupedal habits.

V.—Palæontological Notes from the Manchester Museum: On Mollusca from the Lancashire Coal-measures.

By J. Wilfrid Jackson, F.G.S., Assistant Keeper, Manchester Museum.

In re-arranging the large collection of Coal-measure fossils in the Manchester Museum I have had occasion to revise a number of species (notably in the Wild Collection) which have been recorded in the past under determinations which are now obsolete or erroneous. The object of this communication is to give a few critical remarks on these, as well as to place on record several hitherto unrecorded forms from the Lancashire Coal-field.

Cephalopoda.—The Nautiloid section of this class has already received some attention at the hands of Dr. W. Hind [1],[1] with the result that three new Lower Coal-measure forms have been discovered and some of Wild's former incorrect identifications rectified. Particulars of these will be found in Dr. Hind's paper; it will therefore be unnecessary to deal with them again here.

Two further Nautiloids, not dealt with by Dr. Hind, were also figured by Wild, from the Lower Coal-measures, in his paper [2]. These were given in his "Reference to the Plates" as "*Nautilus temnocheilus* [pl. i, figs. 2 and 3]. Roof of the Bullion Coal, Carre Heys, Colne", and "*Nautilus subsulcatus*, Salter [pl. ii, fig. 5; pl. iii, fig. 3]. Roof of the Bullion Coal, Townhouse, near Colne". No descriptions, however, accompanied the figures. Both these specimens are now in the Wild Collection (M.M.), and I have recently carefully examined them. One of the two examples referred to, "*N. temnocheilus*" (Wild's fig. 2), is a young shell consisting of one or two inner whorls displaying the sutures; this appears to be referable to *Solenocheilus cyclostomus* (Phil.), in which Dr. Hind agrees with me. The original of Wild's fig. 3, which is only a fragment of a whorl, together with another similar example in the Kay-Shuttleworth Collection (M.M.), are also to be referred to Phillips' species. With regard to "*Nautilus subsulcatus*", this has proved on critical examination to be an entirely new species of *Temnocheilus*.

Mr. H. Bolton, in his *Palæontology of the Lancashire Coal-measures* [3, p. 394] (compiled mainly from material in the Manchester Museum), gives a list of Nautiloid forms in the Lower Coal-measures as follows: *Ephippioceras costatum*, *E. clitellarium*, *Cœlonautilus subsulcatus*, *C. quadratus*, *Pleuronautilus falcatus*, *Temnocheilus concavus*, and *T. carbonarius*, stating that he believes examples of most of these species are in the Manchester Museum. The Museum, however, does not appear to possess authentic examples of any of these species from the Lancashire Coal-field, but *E. clitellarium* is represented by some

[1] These numbers refer to the bibliography at end of paper.

fragments from the Coal-measures of Madeley, Salop, and from the Pendleside Series of the Vale of Todmorden; *Pleuronautilus falcatus* and *Temnocheilus carbonarius* by specimens from Coalbrookdale.

Regarding the two species of *Cœlonautilus*, one of Wild's specimens, as has been shown above, was originally figured as *Nautilus subsulcatus* and remained in our collections under this name until recently; it has since been determined as a new species of *Temnocheilus*.

The inclusion of *C. quadratus* as a Coal-measure fossil (though recorded from Coalbrookdale) induced me to carefully look over our collections, with the result that I discovered a specimen in the "Kay-Shuttleworth Collection" labelled and registered as this species and as coming from the "Lower Coal-measures, Burnley". An examination, however, of the matrix, which is a black limestone, convinced me that some mistake had been made in the horizon of this fossil. In order to verify the identification of the species I submitted the specimen to Mr. G. C. Crick, who kindly determined it as follows: "*Cœlonautilus* aff. *quadratus*. Has some resemblance to *C. gradus*, Foord, but seems to come nearest to *C. quadratus* (J. Fleming)." At the same time he identified two other species on the same slab. These associated species are *Prolecanites serpentinus* and *Glyphioceras crenistria*. I have since exposed a specimen of *Posidoniella lævis* and what looks like the anterior end and umbo of a Lamellibranch which is very reminiscent of a Silurian *Grammysia*.

Dr. W. Hind has also seen the specimen, and remarks that it is "not unlike one of the bands of the Great Limestone of Weardale where *Cœlonautilus quadratus* occurs". Questioned further as to its probable Pendleside age, he says "the group suggests a lower horizon than Pendleside, though *Posidoniella lævis* would point to a Pendleside horizon". He quite agrees with me in thinking "not Coal-measures", but considers, like myself, "Black Hall, Bolland" as a possible locality whence the specimen was originally obtained. Two of the species, *Prolecanites serpentinus* and *Posidoniella lævis*, have already been recorded from the Pendlesides of that place [4], but the two other species are new to the list.

Pleuronautilus pulcher, Crick.—The Manchester Museum recently obtained a Nautiloid from Mr. D. M. S. Watson, who collected it from the Lower Coal-measures at Stalybridge, its horizon being "over the 1st coal". This specimen, which is an immature shell displaying the sutures very clearly, has been examined by Dr. Hind and Mr. Crick and pronounced to be *Pleuronautilus pulcher*, Crick. This discovery is interesting, as hitherto the species has only been recorded from the Pendleside Series near Hebden Bridge [5], and from the North Staffordshire Coal-field: 71 feet below the Four-feet Coal, Cheadle [6, p. 541, pl. xxxvi. fig. 3].

Glyphioceras aff. *reticulato* (J. Phillips).—Up to the present time the only record for *Glyphioceras reticulatum* in the Lancashire Coal-measures appears to be that given by Hull [7][1] as follows: "*Goniatites reticulatus*, Phill. Above Lower Lomax, Bury (just beyond the north-east edge of 1 inch map), opposite Broad Oak Mill. Above Gannister Coal."

[1] Referred to later by Bolton, Hind, and Crick.

In working through the "Mark Stirrup Collection" in the Manchester Museum I came across a specimen of a reticulate *Glyphioceras* from the "Upper Foot coal, Bacup", which Mr. Crick has kindly confirmed as *Glyphioceras* aff. *reticulato*, thus constituting a further record.

The species is recorded by Dr. Hind [6, p. 538] from below the Gin Mine Coal, Nettlebank (North Staffordshire Coal-field).

Glyphioceras aff. *striolato* (J. Phillips).—In 1905 the Manchester Museum obtained a number of 'roof nodules' or 'baum pots' from the Upper Foot Mine, Shore, Littleborough, and one of these nodules, on development, has yielded a remarkably large form of a *Glyphioceras* which measures 94 mm. in diameter. The specimen is slightly damaged and somewhat crushed in places, but on the whole is remarkably well preserved and shows the ornamentation of the test to great advantage. No sutures or constrictions, however, are visible. In general appearance it seems to come very near to *Glyphioceras striolatum* (J. Phillips) [=*diadema*, Beyrich (in part)], a large example of which, measuring 66 mm. in diameter, is figured by Messrs. Foord and Crick from Chokier (Belgium) [8].

Glyphioceras diadema has been recorded by Mr. Bolton from the Lower Coal-measures of Lancashire [3, pp. 396 and 413] as follows: "*Glyphioceras* (*Goniatites*) *diadema*. This species is recorded by Messrs. Crick and Foord from the Coal-measures of Rochdale. From the description of the specimen (C. 5098, Brit. Mus.) there is little doubt that the horizon is that of the Bullion or Upper Foot Seam."

Lamellibranchia.—It is much to be regretted that the Mollusca Committee of the Manchester Geological and Mining Society have included in their published list [9] several forms of bivalve mollusca from the Lancashire Coal-measures without first verifying the various records, as this mars what might otherwise have been a useful piece of work. Furthermore, it also leads one to infer, in several cases, the presence of 'marine bands' at the various horizons against which the species are placed.

The following are the chief revisions that it has been found necessary to make, more especially in the Wild Collection, upon which a large part of the above list was based.

"*Schizodus deltoideus*," from the roof of the Bullion Coal, Carre Heys, Colne (Wild and Kay-Shuttleworth Collections), are now regarded as *S. antiquus*, Hind. They compare favourably with the originals of Hind's fig. 27 of pl. xviii [10], now in the Manchester Museum. The specimen figured by Wild [2, pl. ii, fig. 7] as "*Anthracosia*, new angular sp." is considered and figured by Dr. Hind as a young example of *S. antiquus* [10, pl. xix, fig. 6].

"*Posidonomya gibsoni*."—This is a term which has been used in Lancashire for two different shells, viz. *Posidoniella lævis* and *P. minor*. Its use, therefore, should be discontinued, as suggested already by Dr. Hind, in order to avoid further confusion. Wild's specimen (Manch. Mus., W. 630), figured as *P. gibsoni* [2, pl. ii, fig. 8], is *P. lævis*. Its horizon and locality is Sholver, near Oldham, Bullion Coal.

"*Nucula striata*."—This name appears in the *Catalogue of Fossils in*

the Cabinet of Mr. George Wild, etc. [2, p. 396], but there appears to be no specimen under that name in the Wild Collection in the Manchester Museum. There is a *Nucula*, however, in the collection from Carre Heys, Colne (roof of the Bullion Coal), which was figured by Wild as "*Nucula* sp." [2, pl. ii, fig. 3]. This specimen is not very well preserved, and is mounted in Canada balsam on a micro-slide, so that its specific characters are difficult to make out. It strongly resembles *Nucula gibbosa*, Fleming, and in all probability is to be referred to that species.

"*Modiola*."—This name was used by Wild [11, p. 184, and 12, p. 462] to denote certain modioliform bivalves occurring in "dark shale over the Low Bottom Bed at Fulledge Colliery, Burnley", and in the "black shale roof over the 5½ inches coal at 636 yards, Bardsley Colliery". Specimens from these and other localities, preserved in the Manchester Museum, and labelled as "*Modiola*" by Wild, prove to be young forms of *Anthracomya*.

"*Orthonota*."—The same remarks apply here as to the above "*Modiola*". Wild's specimens from the Low Bottom Bed at Fulledge Colliery, Burnley, labelled as "*Orthonota*", are young forms of *Anthracomya wardi*, which species is already recorded for this horizon by Mr. Bolton [3, p. 597], though omitted from the Mollusca Committee's list.

Tellinomya robusta, Bolton [13, p. 5, pl. v, figs. 6–8*a*].—After careful and prolonged study of the actual specimens on which this species was founded, as well as others so named in the Manchester Museum and Chadwick Museum, Bolton, I have come to the conclusion that they are merely interior casts of a species of *Carbonicola*. They present no nuculoid characters at all, but, on account of their tumidity, might very well be casts of such species as *Carbonicola turgida*, with which they have been carefully compared.

The same remark applies to the "*Tellinomya*, n.sp." of Bolton's later paper [3, p. 589], the specimens being casts of either large forms of *Carbonicola turgida*, such as those obtained from the "Stubbs Coal", Bardsley, or of *C. gibbosa*, or even *C. robusta*. In fact, a specimen in the Chadwick Museum, Bolton, from Watergate Colliery, is labelled as "*Carbonicola robusta*".

All the specimens I have so far examined of "*Tellinomya robusta*" and "*Tellinomya*, n.sp." show signs of very considerable wear by water action.

Chænocardiola footii, Baily.—This species was recorded by Dr. Hind [10, p. 475] from the Coal-measures of Burnley, the specimen on which this record was based being in the "Kay-Shuttleworth Collection" (Manchester Museum, L. 2088). The specimen was, until quite recently, stuck down on a cardboard mount, but on detaching it I discovered a label on its underside bearing the legend "Yoredale Shales? Pendle?" This induced me to carefully examine the matrix, which I found to be a black limestone. I have, therefore, no hesitation in stating that it is not a Coal-measure fossil at all, but is, in all probability, to be referred to the same horizon as the *Cœlonautilus* aff. *quadratus* mentioned previously, i.e. the Pendleside Series of Black Hall, Bolland.

Anthracomya phillipsii (Williamson).—Some extraordinary misunderstanding appears to have taken place here with regard to the type-specimen of this abundant Upper Coal-measure form. The example described and figured as the type by Dr. Hind [14, p. 263, pl. x, fig. 27; 15, p. 121, pl. xvi, fig. 10] (Manchester Museum, L. 10106) is labelled on its underside as coming from Ardwick and the matrix is a red shale, whereas Williamson in his original diagnosis [16, p. 351] gives the *Spirorbis* limestone shale of Pendlebury as the horizon and locality whence Dr. C. Phillips obtained the specimens on which the species appears to have been founded. The Ardwick specimen, therefore, can only be regarded as the original of Hind's figures and not as the type-specimen. I have been unable, so far, to trace the original specimen, or, in fact, any examples from the Pendlebury district in the Manchester Museum.

Gasteropoda.—*Raphistoma* (?) *ornata*, Bolton [13, p. 6, pl. v, fig. 10]. The specimen (Manchester Museum, L. 3494) on which this species was founded represents quite a young shell about 1½ to 2 whorls beyond the nepionic stage, and can scarcely be referred to the genus *Raphistoma*, Hall, as defined by De Koninck [17, p. 133]. In my opinion, judging from the fragmentary material at my disposal, it seems to possess greater affinity with the genus *Turbonellina*, De Koninck [17, p. 76], and in all probability is referable to a young stage of one or other of the species placed in this genus by De Koninck. One species, *Turbonellina formosa*, De Kon., has already been recorded by Dr. Hind [6, p. 532] from the marine band below the Gin Mine Coal at Nettlebank (North Staffordshire Coal-field). The horizon and locality of the Manchester Museum specimen is Lower Coal-measures (Bullion Coal), Bacup, Lancs.

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NOTICES OF MEMOIRS.

I.—On the Importance of Africa in Vertebrate Palæontology.[1] By C. W. Andrews, D.Sc., F.R.S. (British Museum, Natural History).

It is a remarkable circumstance that Africa has long been admitted to be one of the oldest land-areas in the world, portions of it not having been submerged since the Permian period or even earlier. The Reptilia from the Permian and Triassic beds of South Africa are of exceptional interest and importance, because they not only include forms which show relationships with the Amphibia, but also give a clue to the manner in which the reptiles gave rise to the mammals. The fact that the mammals originated from these reptiles may be regarded as demonstrated; this is of particular importance, because, if it can be certainly shown that the Mammalia really originated in Africa, and if parts of that continent have been land since this took place, then it is highly probable that somewhere or other there will be found mammalian remains of various periods, linking up the primitive Triassic or early Jurassic mammals with the modern types. Unfortunately, so far, no Secondary mammalian remains have been found.

When we come to the Tertiary period the case is different, primitive members of the orders Proboscidea, Hyracoidea, and Sirenia having been discovered in the Middle and Upper Eocene beds of the Fayum district of Egypt. These same beds have also yielded remains of animals which show that the anthropoid apes and toothed whales probably originated in the same region. Besides these there are a number of remarkable forms which seem to have died out without leaving any descendants in the fauna of to-day. One of these, *Arsinoitherium*, was a huge hoofed animal carrying a pair of large horns on the nose, and quite unlike anything known elsewhere.

Up to this period Proboscidea are known only from Egypt, but between the Upper Eocene and the Lower Miocene, the next horizon at which they have been found, they had spread over much of the world, having passed out of Africa along some land connexion with Europe or Asia, which broke down the isolation of that part of Africa in which they had originated; the anthropoid apes, Hyraxes, and other members of the same fauna, no doubt spread north with them. In the lowest Miocene beds of Europe and India the Proboscidea are represented by two distinct types. One, *Tetrabelodon*, is really a Palæomastodon with its peculiarities exaggerated; the other form, *Dinotherium*, is very different and presents peculiarities not found in any other of the elephants. In deposits of the same age at Mogara, in Egypt, only *Tetrabelodon* occurs, nor was it known till quite recently that *Dinotherium* had existed in any part of Africa. Last year, however, Mr. C. W. Hobley sent to the British Museum a fragment of a mandible with molars which undoubtedly belongs to a small species of *Dinotherium*, closely similar to *Dinotherium*

[1] From the Journal of the East Africa and Uganda Natural History Society, vol. ii, No. 4. (Abstract.)

cuvieri, a species found in the Lower Miocene beds of France. This specimen was collected by the late Mr. Botry Piggot at Karungu, near the south-eastern shore of Lake Victoria Nyanza, and is the first early Tertiary mammal recorded from tropical Africa. It is of the greatest interest, because it proves the possibility, and even the probability, of mammalian faunas of various ages occurring in that region, and also shows that the separation of *Dinotherium* from the rest of the Proboscidean stock most likely took place in Africa, where the intermediate links may therefore be expected to be found. The finding of this specimen shows what great possibilities of the discovery of completely new forms of extinct animals are afforded by British East Africa. An expedition to German East Africa has already found remains of a gigantic Dinosaur, some of the bones of which are about twice the size of those of the well-known *Diplodocus carnegii*, a reptile which was about 80 feet long. Now this discovery of a new mammalian fauna of Miocene age gives great hopes that in the near future important additions to our knowledge of this region may be made. It is greatly to be desired that anyone finding teeth or bones (or even fragments of them) that appear to be in a fossil condition, should send them to the British Museum for determination; for even though the specimens themselves may not be very good, they may be sufficient to determine whether further collecting on the spot would be likely to lead to valuable results.

II.—BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DUNDEE, 1912.

The Relation between the Cambrian Faunas of Scotland and North America.

Address to the Geological Section by B. N. Peach, LL.D., F.R.S.
(President of Section C).

Introduction.

Ever since the announcement made by Salter in 1859 that the biological affinities of the fossils found in the Durness Limestone are more closely linked with American than with European forms, the relation between the older Palæozoic faunas of Scotland and North America has been a subject of special interest to geologists. The subsequent discovery of the *Olenellus* fauna in the North-West Highlands furnished striking confirmation of Salter's opinion. This intimate relationship raises questions of prime importance bearing upon the sequence and distribution of life in Cambrian time in North America and North-West Europe, on the probable migration of forms from one life-province to another, and on the palæogeographical conditions which doubtless affected these migrations.

On this occasion, when the British Association revisits the border of the Scottish Highlands, it seems appropriate to refer to some of these problems. With this object in view I shall try to recapitulate briefly the leading features of the life-history of Cambrian time in Scotland and North America, to indicate the relation which these life-provinces bear to each other, and, from these data, to draw some inferences regarding the probable distribution of land and sea which then obtained in those regions.

The two great rock groups in Scotland that are universally admitted to be older than Cambrian time are the Lewisian Gneiss and the

Torridon Sandstone. The Lewisian Gneiss, as mapped by the Geological Survey, consists mainly of igneous rocks, or of gneisses and schists of igneous origin. But, in addition to these materials, we find, in the Loch Maree region, schists of sedimentary origin, comprising siliceous schist, mica-schist, graphite-schist, limestone, chert, and other sediments. The association of graphite-schist with limestone and chert suggests that we are here dealing with rocks that were formed at or near the extreme limit of sedimentation, where the graphite, the limestone, and the chert were probably accumulated from the remains of plankton. But this assemblage has been so completely altered into crystalline schists that all traces of original organic structure in them have been destroyed.

The Torridonian strata were evidently accumulated under desert or continental conditions, and could therefore furnish little or no evidence bearing upon the development of marine life. That life existed, however, is clear from the presence of phosphatic nodules, containing remains of cells and fibres of organic origin, in the upper division of the system, and from the presence of worm burrows and casts in the Diabaig Beds (Lower Torridon).

Geologists are familiar with the fact that the Cambrian faunas all over the globe present highly specialized types belonging to most of the great groups of marine invertebrate life. Scotland is no exception to this general rule. For the fossils prove that their ancestors must have had a long history in pre-Cambrian time.

The Cambrian Fauna of Scotland.

Beginning with the false-bedded quartzites forming the basal subdivision of the Cambrian strata in the North-West Highlands, we find no traces of organic remains in them, except at one locality, where worm casts (*Scolithus linearis*) were obtained. In the upper subdivision of the quartzites—the pipe-rocks—the cylinders of sand are so numerous that the beds have been arranged in five sub-zones, based on a definite order of succession of different forms probably of specific value. One of them, *Arenicolites* of Salter, may be of generic importance. Worms of this habit are confined to comparatively shallow water, and therefore near the shore-line. Their occurrence helps to confirm the belief that the quartzites were laid down on an ancient shelving shore-line during a period of gentle subsidence. Their presence also indicates the existence of plankton, from which they derived nourishment. Besides the relics of these burrowing Annelids, one of the sub-zones of the pipe-rock has yielded specimens of *Salterella* (*Serpulites Maccullochii*)—a tubicolar Annelid, which becomes more abundant in the overlying fucoid beds, serpulite grit, and basal limestone, where it is associated with *Olenellus* and other typical Lower Cambrian forms.

The fucoid beds, which immediately overlie the pipe-rocks, consist chiefly of shales and brown dolomitic bands, with intercalations of grit locally developed. This type of sedimentation indicates that the mud-line was superimposed on the shore-line by subsidence. With this change of conditions there is a change of organisms, for though the burrowing forms (*Scolithus*) are still to be found in the sandy layers, the most characteristic types are those occurring along the bedding planes, known under the name of *Planolites* (Nicholson). They are very varied forms, and were probably produced by many types of errant Annelids. The tubicolar Annelids are represented by *Salterella*, *Coleoloides*, and *Hyolithes*—an organism which perhaps links the worms with the hingeless Brachiopods. This suggestion gains additional support from the researches of Dr. Walcott in the Middle Cambrian rocks of Canada. It is interesting to note that small Annelids seem to have bored the spines of dead Trilobites. Walcott has found similar borings in the chetæ of Annelids in the Middle Cambrian rocks of Canada.[1]

[1] Smithsonian Misc. Coll., vol. lvii, No. 5, p. 125, 1911.

The researches of Dr. Walcott have proved beyond doubt that representatives of nearly all the divisions of the Annelids are entombed in the Middle Cambrian rocks of Mount Stephen, in British Columbia. We may therefore reasonably infer that the worm casts of *Scolithus* type found in the North-West Highlands are due to Annelids. He has also shown that worm-like Holothurians are to be found in the same beds.[1] In this connexion it may be observed that some of the recent Holothurians have much the same habit of obtaining nourishment from the sands and silts containing organic matter.

Fragments showing the characteristic microscopic structures of the plates and ossicles of Echinoderms have been found in the fucoid beds. These are probably Cystidean. Hingeless forms of Brachiopods also occur, among which may be mentioned *Paterina labradorica* and *Acrothele subsidua*. The type of *Acrothele* suggests a genetic descent from such a tubicolar worm as *Hyolithes*. Of the Gasteropods, only one specimen, belonging to a sub-genus of *Murchisonia*, has been obtained at one locality in Skye. *Helenia bella*, a curved calcareous tube, open at both ends, doubtfully referred to the Dentalidæ by Walcott, is comparatively plentiful. It occurs also in the *Olenellus* zone in Newfoundland.

But the organic remains that render the fucoid beds of exceptional interest and importance are the Trilobites, because they clearly define the horizon of this zone in the Cambrian system and display strong affinities with American types. They are represented by five species and varieties of *Olenellus*, very closely resembling the forms in the Georgian terrane, or *Olenellus* zone, on the east and west sides of the North American continent. The genus *Olenelloides* has also been recorded from these beds. The Crustacea are represented by Phyllocarids, among which we find *Aristozoe rotundata*, likewise characteristic of the *Olenellus* zone of North America.

Next in order comes the serpulite grit, which indicates a recrudescence of the pipe-rock conditions of deposition, and presents the *Scolithus* type of Annelid borings. From the diameter of the pipe and the depth of the burrow it is probable that the worm may have belonged to a different species from any of those whose casts are to be found in lower horizons. This large variety is associated with smaller and more irregular worm casts which have often weathered out and leave the rock honeycombed with hollow casts. The characteristic form from which the zone takes its name is *Salterella* (*Serpulites Maccullochii*). It occurs abundantly along certain calcareous layers that mark pauses in the deposition of the sand. This calcareous type culminates at the top of the zone, where there is a thick, carious, weathering band, crowded with specimens of *Salterella*, forming a passage bed into the calcareous shales at the base of the Durness dolomites. At one locality near Loch an Nid, Dundonnell Forest, Ross-shire, thin shales, intercalated in the serpulite grit, yielded a fine carapace of *Olenellus Lapworthi*—a form of frequent occurrence in the underlying fucoid beds. Professor Lapworth recorded the finding of *Orthoceras* and linguloid shells in the top part of this zone at Eireboll.[2]

Immediately above the serpulite grit in Eireboll and Assynt we find a few feet of dark calcareous shale, with iron pyrites, probably deposited at the limit of sedimentation. This layer, which is singularly devoid of organisms, ushers in the great succession of dolomites and limestones, upwards of 1,500 feet in thickness—perhaps the most remarkable type of sedimentation among the Cambrian rocks of the North-West Highlands. The Geological Survey has divided this calcareous sequence into seven well-marked groups, some of which have as yet yielded no fossils beyond worm casts. Attention will presently be

[1] Smithsonian Misc. Coll., vol. lvii, No. 3, 1911.

[2] GEOL. MAG., 1883, p. 126.

directed to the absence of calcareous forms in many of the bands of dolomite and to the probable cause of their disappearance.

The thin calcareous shale just referred to is followed by dark-blue dolomite limestone, forming the basal portion of the Ghrudhaidh group. It contains sparsely scattered, well-rounded sand grains, with a bed about 3 feet thick, near the bottom, charged with *Salterella pulchella* and *S. rugosa*. In the overlying 20 feet of dolomite the sand grains gradually disappear, and the rock assumes a mottled character, due to innumerable worm casts of the *Planolites* type. Here a second layer, yielding *Salterella pulchella* and *S. rugosa*, supervenes, both forms occurring in the *Olenellus* zone of North America.

The brief summary of the palæontological evidence which has just been given clearly shows that the strata ranging from the middle of the pipe-rock zone to the upper *Salterella* band of the Durness dolomites represent in whole or in part the *Olenellus* zone of North America. Owing to the absence of fossils we have no means of deciding more definitely the base and top of the Lower Cambrian rocks of the North-West Highlands. All the quartzites lying below the middle of the pipe-rock, notwithstanding the absence of zonal forms, have been included in the Lower Cambrian division. This correlation receives some support from the remarkable discovery of Dr. Walcott, who found primitive Trilobites several thousand feet beneath the beds yielding *Olenellus Gilberti*, the form closely allied to the Highland Trilobites.

On the other hand, when we pass upwards for a certain distance from the *Salterella* bands the evidence is insufficient to establish the stratigraphical horizon of the beds. For, in the overlying strata comprising the remainder of the Ghrudhaidh group, the whole of the Eilean Dubh group, and the lower part of the Sail Mhor group, and consisting of dolomites, limestones, and cherts, with little or no terrigenous material, the only fossils that can be shown to be due to organisms are worm casts of the nature of *Planolites*, although the limestone and chert may have originated from the debris of the calcareous and siliceous organisms of the plankton. A noticeable feature of the Ghrudhaidh and Eilean Dubh groups is the occurrence in them of bands of brecciated dolomite on several horizons, which do not imply any break in the continuous sequence of deposits. The total thickness of this portion of the Durness dolomites and limestones, yielding no fossils beyond worm casts, amounts to 350 feet.

But in the upper part of the Sail Mhor group siliceous and calcareous organisms of a higher grade make their appearance. Among the former we find the *Rhabdaria* of Billings. The calcareous forms are represented by (1) Gasteropods, including a single specimen of a Murchisonid, two species of a Pleurotomarid (*Euconia Ramsayi* and *E. Etna*) of a type occurring in the calciferous rocks of Newfoundland and Canada; (2) Cephalopods, comprising two slightly bent forms with closely set septa and wide endogastric siphuncles, showing affinities with those of *Endoceras* and *Piloceras*; (3) Arthropods, represented by the epitome of a large asaphoid Trilobite resembling that of *Asaphus canalis* of Conrad. This evidence is insufficient to determine the exact horizon of these beds, but clearly indicates that we are no longer dealing with Lower Cambrian strata. The Cephalopods are like those found in the Ozarkic division of Ulrich (Upper Cambrian), in North America. According to Schuchert, the Cephalopods with closely set septa are of Cambrian type and older than those of the Beekmantown terrane of American geologists. On the other hand, the asaphoid type of Trilobite is suggestive of a somewhat higher horizon.

No fossils have been found in the overlying Sangomore group, about 200 feet thick, which consists mainly of granular dolomite, with bands of chert, some being oolitic, together with thin fine-grained limestones near the top.

Above this horizon, at a height of over 800 feet above the top of the *Olenellus* zone, we encounter the great home of the fossils peculiar to the Durness Limestone in the Balnakeil and Croisaphuill groups. The former consists mostly of dark limestones, with nodules of chert, and, with a few alternations, of white limestone bands. A few thin layers are charged with worm casts. The overlying group is more varied, the lower part being composed of dark-grey limestones full of worm casts, and with some small chert nodules arranged in lines; the middle portion, of dark granular and unfossiliferous dolomite; and the upper part, of massive sheets of fossiliferous limestone full of worm casts. The total thickness of these two groups in Durness is about 550 feet.

These two subdivisions have yielded over twenty genera and about one hundred species. In Durness sixty-six species have been obtained from the Balnakeil group alone, fifteen of which have not as yet been found in the overlying Croisaphuill group, thus leaving fifty-one species common to both divisions. The Ben Suardal limestones in Skye, which were mapped by the Geological Survey as one division, are regarded, on palæontological grounds, as the equivalents of both these groups. Owing to the number of species common to both subdivisions, the fauna will be here referred to as a whole.

Both siliceous and calcareous organisms are present in this fauna. Among the former we find *Archæoscyphia* (Hinde), described by Billings as *Archæocyathus*, an early Cambrian coral, but shown by Hinde to be a siliceous sponge.[1] The genus *Calathium* is represented by four species. Other genera and species of sponges occur, so that the siliceous nodules, which are very common in both groups, may be in great part due to them. In this connexion it may be mentioned that Hinde obtained sponge spicules from some of the nodules. Hinged Brachiopods have also been collected from these beds, and include *Nisusia* (*Orthosina*) *festinata*, *N. grandæva*, and *Camarella*.

But the characteristic feature of the fauna is the assemblage of calcareous Mollusca comprising Lamellibranchs, Gasteropods, and Cephalopods, showing a wide range of variation, and consequently a long ancestry. The Lamellibranchs, though represented only by two genera, *Euchasma* and *Eopteria* of Billings, with several intermediate forms, are of extreme interest, as they are only known to occur elsewhere in Newfoundland and Eastern Canada. The Gasteropods, however, furnish the largest number of species—about 48 per cent of the whole. The primitive Euomphalids, *Maclurea* and *Ophileta*, are most characteristic. The former genus has a large number of species, many of which are to be found in the Beekmantown Limestone of Newfoundland and Eastern North America. Only one of the species (*Maclurea Peachi*) is peculiar to Durness. Several species of *Ophileta* are found, some of which likewise occur in the Beekmantown Limestone. *Euomphalus* has also been recorded, while several forms belonging to the nearly allied family of the Turbinidæ, and placed in Lindström's genus *Oriostoma*, are also met with in the Beekmantown Limestone.

Murchisonids and Pleurotomarids number twenty-seven species and show a very wide range of variation. The chief sub-genera of the former are *Hormotoma* and *Ectomaria*, many species of which occur with remarkable variations. All the types of variation found in Durness are to be found in North America, and several of the species are common to both regions. The Pleurotomarids vary in a similar manner, the chief genera being *Raphistoma* and *Euconia*, and a form resembling *Hormotoma*, only with a shorter spire. Species belonging to each of these sub-genera are likewise common to both areas, while some are only known from the North-West Highlands.

The Cephalopods are of equal interest. They are also of primitive type, and, at the same time, show a wide range in form. The

[1] Quart. Journ. Geol. Soc., vol. xlv, p. 125, 1889.

prominent feature in the straighter specimens is the great width of the laterally placed siphuncle, which is generally furnished with endocones and organic deposits. The genus *Piloceras* is the most characteristic type, and shows this peculiar feature best. It has only been recorded from Scotland, Newfoundland, Canada, and the eastern States of North America. The following additional genera are represented, viz., *Endoceras*, chiefly by siphuncles in great variety, *Actinoceras*, *Cyrtoceras*, and, doubtfully, *Orthoceras*. Several forms have been attributed to *Orthoceras*, which, on re-examination, have been found to be the siphuncles of other genera, resembling American types described by Hall and Whitfield.

The whorled Nautiloids provisionally classed with the genus *Trocholites* of Conrad are represented by several distinct forms as yet unnamed.

The Trilobites are of rare occurrence in these two groups of dolomite and limestone. They are fragmentary and poorly preserved. This is doubtless one of the disappointing features connected with this remarkable assemblage of organic remains, for the presence of a zonal form would have helped to define the horizon of these beds. Only one species, *Bathyurus Nero* (Billings), has been identified, which also occurs in the Beekmantown Limestone of Newfoundland. The other Trilobite remains, though poorly preserved, have a Cambrian facies characteristic of North America.

In connexion with this fauna certain features have been observed which throw some light on the absence of calcareous organisms from thick zones of the Durness dolomite and limestone. In my detailed description of the palæontology of the Cambrian rocks of the North-West Highlands in the Geological Survey Memoir, I stated that "in most cases the septa and walls of chambered shells have been wholly or in part dissolved away, so as to leave only the more massive structures of the siphuncles, and worm castings are often found within the chambers where the septa have been preserved. These features seem to indicate that the accumulation of the calcareous mud in which the fossils were embedded was so slow that there was time for the solution of part of an organism before the whole of it was covered up".[1] There is good reason to believe that many organisms wholly disappeared by this process, so that it is reasonable to conclude that the fossils obtained from the Durness dolomites cannot be regarded as furnishing a complete life-history of the forms that originally existed in that sequence of deposits. Attention has already been called to the fact that beneath the two subdivisions now under consideration there are groups of dolomite and limestone which so far have yielded no organic remains beyond worm castings. And even in the important Croisaphuill group, with its fossiliferous zones, there are thick groups of dolomite which have furnished no calcareous organic remains. Obviously the palæontological record in this instance is glaringly incomplete, for we have no reason to suppose that the life of the time flourished in some of the calcareous zones and not in others.

The highest subdivision of the Durness Limestone, measuring about 150 feet in thickness (Durine group), has yielded two species of *Hormotoma*—viz. *H. gracilis* and *H. gracillima*—both of which occur in the two underlying groups. *H. gracilis* occurs in the Beekmantown, the Chazy, and the Trenton Limestones of America.

Before assigning any stratigraphical horizons to the fauna of the Durness dolomites, it is desirable, owing to the American facies of the fossils, to recapitulate the evidence bearing upon the life of Cambrian time in North America. But the Cambrian life-history of Scotland would be incomplete without a brief reference to the recent discovery of fossils along the eastern border of the Highlands.

[1] *Geological Structure of the North-West Highlands*: Geol. Surv. Mem., 1907, p. 380.

In 1911 Dr. Campbell announced in the GEOLOGICAL MAGAZINE that fossils had been found in the Highland border series north of Stonehaven, and, during this year, Dr. Jehu made a similar discovery in rocks belonging to this series near Aberfoyle. Papers on these subjects will be communicated to this section. For my present purpose it will be sufficient to indicate the nature of the fossils and the lithological characters of the rocks containing them.

The Highland border series north of Stonehaven and near Aberfoyle includes sheared igneous rocks, both lavaform and intrusive, with black shales, cherts, and jaspers. North of Stonehaven the fossils occur in thin, dark, flinty pyritous shale, while at Aberfoyle they have been found in shaly films at the edge of the chert bands. Several years ago Radiolaria were detected in the cherts between Aberfoyle and Loch Lomond. From time to time these Highland border rocks have been carefully searched for fossils, but until recently with little success, owing to the intense movement to which they have been subjected, resulting in marked flaser structure in all except the most resistant bands.

The fossils consist chiefly of horny, hingeless Brachiopods, Phyllocarid Crustacea, worm tubes, and the jaws and chetæ of Annelids. The genera of Brachiopods comprise *Lingulella*, *Obolus*, *Obolella*, *Acrotreta*, and *Linarssonia*. The association of these Brachiopods with Phyllocarid Crustaceans resembling *Hymenocaris* and *Lingulocaris* is suggestive of an Upper Cambrian horizon—an inference which is supported by the absence of Graptolites.

In the published Geological Survey maps these Highland border rocks are queried as of Lower Silurian age. This correlation was based partly on their resemblance to the Arenig volcanic rocks and Radiolarian cherts of the Southern Uplands, and partly because, as shown by Mr. Barrow, they are overlain by an unconformable group of sediments, termed by him the Margie Series. The cherts, the green schists, and the Margie Series have shared in a common system of folding, and are unconformably surmounted by Downtonian strata near Stonehaven. Though the original correlation may not be strictly correct, it is probable, in my opinion, that representatives of both the Arenig and Upper Cambrian formations may occur in the Highland border series, and, further, that Upper Cambrian strata may yet be found in the Girvan area, as originally suggested by Professor Lapworth in correspondence with Dr. Horne.

The Cambrian Fauna of North America.

[We are unable, from want of space, to give the particulars here related by Dr. Peach, and therefore quote only the conclusions at which he has arrived.]

The palæontological evidence adduced regarding the relation of the Cambrian fauna of the North-West Highlands to that of North America leads to the following conclusions:—

1. The Lower Cambrian fauna of the North-West Highlands, distinguished by the genus *Olenellus* and its associates, is almost identical in character with that of the Georgian terrane of the western life-province of North America, and essentially different from the Lower Cambrian fauna of the rest of Europe.

2. No forms characteristic of the Middle Cambrian division, either of Europe or North America, have as yet been found in the North-West Highlands; but this division may be represented by the unfossiliferous dolomites and limestones of the Ghrudhaidh, Eilean Dubh, and the lower Sail Mhor groups.

3. The fossiliferous bands of the Sail Mhor group may be the equivalents of the lower part of the Upper Cambrian formation.

4. The Balnakeil and Croisaphuill groups of the Durness dolomites

and limestones contain a typical development of the molluscan fauna of the Beekmantown Limestone, belonging to the western life-province of North America. As the Beekmantown Limestone is succeeded by shales, with Arenig Graptolites, it follows, in accordance with British classification, that these groups must be of Upper Cambrian age.

5. The highest subdivision of the Durness Limestone (Durine) has not yielded fossils of zonal value, and the members of this group are not overlain in normal sequence by graptolite-bearing shale or other sediments.

Cambrian Palæogeography between North America and North-West Europe.

In attempting to restore in outline the distribution of land and sea in Cambrian time between North America and North-West Europe, reference must be made to various investigators whose researches in palæogeography are more or less familiar to geologists. Among these may be mentioned Suess, Dana, De Lapparent, Frech, Walcott, Ulrich, Schuchert, Bailey Willis, Grabau, Hull, and Jukes-Browne. The views now presented seem to me to be reasonable inferences from the palæontological evidence set forth in this address.

In the North-West Highlands there is still a remnant of the old land surface upon which the Torridonian sediments were laid down. There is conclusive evidence that the pre-Torridonian land was one of high relief. As the Torridonian sediments form part of a continental deposit it may be inferred that the Archæan rocks had a great extension in a north-westerly direction. The increasing coarseness of the deposits towards the north-west suggests that the land may have become more elevated in that direction. At any rate, the pile of Torridonian sediments points to a subsidence of the region towards the south-east, and probably to a correlative movement of elevation towards the north-west.

The sparagmite of Scandinavia is an arkose resembling the dominant type of the Torridon Sandstone; is of the same general age, and has evidently been derived from similar sources in the Scandinavian shield. In eastern North America coarse sedimentary deposits form part of the newer Algonkian rocks, which are still to be found rising from underneath the Cambrian strata in the region of the great lakes. These materials were obtained from the great Canadian shield, which must have formed a large continental area during their deposition.

It is reasonable to infer that these isolated relics of old land surfaces were united in pre-Torridonian time, thus forming a continuous belt from Scandinavia to North America. During the period which elapsed between the deposition of the Torridon Sandstone and the basement members of the Cambrian system a geosyncline was established which gave rise to a submarine trough, trending in an east-north-east and west-south-west direction, both in the British and North American areas. In the latter region it extends from Newfoundland to Alabama, its south-eastern limit being defined by the old land surface of Appalachia. The extension of this Appalachian land area in a north-east direction beyond the limits of Nova Scotia and Newfoundland was postulated by Dana and other American writers. This geosyncline remained a line of weakness throughout Palæozoic time, both in Britain and North America, which resulted in the Caledonian system of folding in Britain, and in the Taconic, Appalachian, and Pennsylvanian systems in North America. Hence it is manifest that the original shore-lines of this trough are now much nearer each other than they were in Cambrian time.

The Cambrian rocks of the North-West Highlands were laid down along the north-west side of this trough during a period of subsidence, for the great succession of Durness dolomite and limestone, with little or no terrigenous material, is superimposed on the coarser sediments of

that formation. On the other hand, the Cambrian strata of Wales seem to have been deposited along the southern limit of this marine depression. The Archæan rocks that now constitute the central plateau of France may have formed part of its southern boundary. The extension of this land area towards the north-east may have given rise to the barrier that separated the Baltic life-province from that of Bohemia, Sardinia, and Spain. In my opinion, this southern land area in Western Europe was continuous across the Atlantic with Appalachia. For the life sequence found in the Cambrian rocks of New Brunswick is practically identical with that of Wales and the Baltic provinces, thus showing that there must have been continuous intercourse between these areas. Along this shore-line the migration of forms seems to have been from Europe towards America. On the other hand, along the northern shore the tide of migration seems to have advanced from America towards the North-West Highlands. The question naturally arises, what cause prevented the migration of the forms from one shore of this trough to the other? American geologists are of opinion that this is probably due to the existence of land barriers; but, in my opinion, it can be more satisfactorily accounted for by clear and open sea, aided by currents.

The south-western extremity of the American trough in Lower Cambrian time opened out into the Mississippian sea, which was connected with the Pacific Ocean, and stretched northwards towards the Arctic regions. Reference has already been made to Walcott's discovery in Nevada of the primitive Trilobite *Nevadia Weeksi*, from which he derives both branches of the Mesonacidæ, one branch linking *Nevadia*, through *Callavia*, *Holmia*, and *Wanneria*, with *Paradoxides*, the other connecting *Nevadia* with *Olenellus*, through *Mesonacis*, *Elliptocephalus*, and *Pædumias*.

In Nevada the genus *Holmia*, as already shown, is associated with the primitive type *Nevadia*. *Wanneria* is found in Nevada, in Alabama, and in Pennsylvania, thus showing that this genus is common to the Mississippian sea and to the long trough north-east of Alabama. *Mesonacis* has been obtained in the submarine depression at Lake Champlain, at Bonne Bay, Newfoundland, and at the north side of the Straits of Belle Isle. *Elliptocephalus* has been recorded from the New York State. *Olenellus* has been found in Nevada, in Vermont, and in the North-West Highlands. All the genera now referred to may have migrated along the north-western shore of this trough.

As regards the distribution of the genus *Callavia*, this form has been met with in Maine, in Newfoundland, and in derived pebbles in a conglomerate in Quebec. Two species have been recorded in Shropshire. These forms probably moved along the southern shore of this sea from Wales to North America.

Reference has already been made to the fact that, in the interval between Lower and Middle Cambrian time, in certain areas in North America, the Lower Cambrian rocks were locally elevated and subjected to erosion. During this interval the southern end of the trough seems to have had no connexion with the Mississippian sea, for in Middle Cambrian time, as already indicated, the *Paradoxides* fauna is found in the trough on the east side of North America, whereas on the west side it is represented by the *Olenoides* fauna.

In Upper Cambrian time a great transgression of the sea towards the north supervened. The *Dikelocephalus* fauna is found on both sides of America, thus showing that the previous land barrier had been submerged. While this genus occurs in Wales and the Baltic provinces, it has not as yet been recorded from the North-West Highlands, but I quite expect that this discovery may be made at some future time.

Along the northern side of the American trough clear-water conditions prevailed, owing to the northward recession of the shore-line, which

led to the accumulation of a great succession of calcareous deposits, including the Beekmantown Limestone, to which reference has already been made. Schuchert, as already stated, has pointed out that, in the lower part of the Ozarkic (Upper Cambrian) System, in Minnesota and Wisconsin, the Gasteropod genera *Holopea*, *Ophileta*, and *Raphistoma* are associated with two species of *Dikelocephalus*. This molluscan fauna is evidently the precursor of that of the Beekmantown Limestone. It was probably from this central region of America that the calcareous fauna of Beekmantown migrated to the submarine trough in the typical Champlain region, and through Newfoundland to the North-West Highlands of Scotland.

The section at St. John, New Brunswick, where the Baltic and Welsh types of the *Olenus* fauna occur, shows that the southern shore-line of the trough must then have occupied much the same relative position as in Lower and Middle Cambrian time. In the same region the strata containing this fauna, with *Peltura scarabæoides* and *Dictyonema flabelliforme*, are overlain by dark shales with Arenig Graptolites. These Graptolite-bearing terrigenous deposits eventually extended across the trough northwards, till, in Newfoundland, they came to rest on the Beekmantown limestones.

In the Lake Champlain region, in the Chazy Limestone, which there immediately succeeds the Beekmantown Limestone without the intervention of the Arenig Graptolite shale, there is a survival of the Beekmantown molluscan fauna with only such slight modifications as to indicate genetic descent. In the same trough the descendants of this fauna are to be found in the Trenton Limestone.

In this connexion it is worthy of note that the molluscan fauna and the corals of the Stinchar and Craighead Limestones of Upper Llandeilo age in the Girvan district of the Southern Uplands have an American facies, as first suggested by Nicholson. The appearance of American types in these limestones may be accounted for in the following manner: Attention has already been called to the divergent types of sedimentation presented by the Upper Cambrian strata of the North-West Highlands and of the South-East Highlands, at Stonehaven and Aberfoyle. In the former case there is a continuous sequence of dolomites and limestones, while in the latter we find a group, comprising Radiolarian cherts and black shales, associated with pillowy spilitic lavas and intrusive igneous rocks, indicating conditions of deposition at or near the limit of sedimentation. But, notwithstanding the different types of sedimentation and the divergent faunas in the two areas, I believe that during the Upper Cambrian period, and probably for some time thereafter, continuous sea extended from the North-West Highlands to beyond the Eastern Highland border. The Upper Cambrian terrigenous sediments which we now find at Stonehaven and Aberfoyle must have been derived from land to the south. In Llandeilo time the Arenig and Lower Llandeilo rocks of the Girvan area were elevated and subjected to extensive denudation. On this highly eroded platform, as first proved by Professor Lapworth, coarse conglomerates, composed of the underlying materials, were laid down in association with the Stinchar and Craighead Limestones. In my opinion the appearance of the American forms in these limestones is connected with the movement that produced this unconformability in the Girvan area. This local elevation was probably associated in some form with the great crustal movements that culminated in the overthrusts of the North-West Highlands and caused the intense folding and flaser structure of the rocks along the Highland border. By these movements shore-lines may have been established between the north side of the old Palæozoic sea and the Girvan area, which permitted the southern migration of the American forms.

Note. Since writing the above my attention has been directed to the recent work of Bassler on *The Early Palæozoic Bryozoa of the Baltic*

Provinces, published by the Smithsonian Institution in 1911. In his introduction the author has shown that the Ordovician (Lower Silurian) and Gothlandian (Upper Silurian) rocks of the Baltic Provinces contain a large percentage of Bryozoan species, in common with the Black River, Trenton, and Niagara Limestones of the same relative age in Eastern North America. This fact suggests that during Lower and Upper Silurian time the old lines of migration were still open, and that the Bryozoa, being of clear-water habit, were able to cross the old trough from side to side.

III.—British Association for the Advancement of Science, Eighty-second Annual Meeting, held at Dundee, September 4–11, 1912. List of Titles of Papers read in Section C (Geology) and in other Sections bearing upon Geology.

Presidential Address by *Dr. Benjamin N. Peach, F.R.S.*

Professor Thomas J. Jehu.—Address on the Geology of the Country around Dundee and St. Andrews.

Mr. E. B. Bailey.—A Mull Problem: The Great Tertiary Breccia.

Mr. C. I. Gardiner.—On the Silurian Inlier of Usk.

Mr. T. O. Bosworth.—The Heavy Mineral Grains in the Sandstone of the Scottish Carboniferous.

The Rev. A. Irving.—Preliminary Note on a Buried River Channel near Peterborough.

Report of the Committee on the Composition and Origin of the Crystalline Rocks of Anglesey.

Report of the Committee on the Bembridge Limestone at Creechbarrow Hill.

Dr. Robert Campbell.—The Discovery of Fossils in the Jasper and Green Schist Series of the Highland Border at Craigevin Bay, Stonehaven.

Dr. Robert Campbell.—The Downtonian and Old Red Sandstone of Kincardineshire.

Dr. R. H. Traquair, F.R.S.—On *Cyathaspis* from the Downtonian Rocks of Stonehaven.

Professor T. J. Jehu.—Discovery of Fossils in the Boundary Fault Series near Aberfoyle.

Mr. Archibald W. R. Don.—On the Nature of *Parka decipiens.*

Mr. John H. Wilson.—Uncharted Volcanic Necks at St. Andrews.

Report of Committee on the *Index Animalium* (also in Section D, Zoology).

Dr. John S. Flett.—The Sequence of Volcanic Rocks in Scotland in relation to the Atlantic–Pacific Classification of Suess.

Mr. George Barrow.—The Older Granite in Lower Dee-side.

Mr. G. W. Tyrrell.—The Alkaline Igneous Rocks of Ayrshire.

Dr. William Mackie.—The Volcanic Rocks around the Ord Hill of Rhynie, Aberdeenshire.

Dr. A. W. Gibb.—On an Actinolite-bearing Rock associated with Serpentine.

Mr. Edward Greenly.—On the Origin of some of the Mica-schists of Anglesey.

Mr. Albert Gilligan.—The Millstone Grit of Yorkshire—New Evidence of its Source of Origin.

Mr. Albert Jowett.—Notes on the Volcanic Rocks and their Associated Sediments of the Forfarshire Coast between the Red Head and Montrose.

Dr. W. T. Gordon.—The Fossil Flora of the Pettycur Limestone in relation to Botanical Evolution.

Dr. Marie C. Stopes.—Palæobotany *versus* Stratigraphy in New Brunswick.

Dr. B. N. Peach, F.R.S., & Dr. J. Horne, F.R.S.—The Archæan Rocks of the Island of Lewis.

Dr. J. S. Owens.—The Settlement and Transport of Sand in Water.

Mr. George Barrow.—On Buckled Folding.

Mr. Edward Greenly.—A Theory of the Menai Strait.

Mr. J. D. Falconer.—On the Origin of 'Kopjes' and 'Inselberge'.

Mr. G. W. Grabham.—Note on the Country North of Lake Albert.

Dr. J. W. Spencer.—Post-Glacial Changes of Level *versus* Recent Stability of the Lake Region of North America.

Mr. A. R. Horwood.—On a Fossiliferous Tufa occurring beneath Chalky Boulder-clay at Launde, Leicestershire.

Section A.—Mathematical and Physical.

Dr. J. Milne, F.R.S.—Report on Seismological Investigations.

Section E.—Geography.

Presidential Address by *Colonel Sir Charles M. Watson, K.C.M.G.*

Colonel C. F. Close.—The International Map.

Mr. E. A. Reeves.—Recent Improvements in Surveying Instruments.

Dr. H. M. Ami.—Geographical Progress in Canada.

Sir H. G. Fordham.—Notes on British and Irish Itineraries and Road Books.

Sir Clements Markham.—Antarctic Discovery.

Dr. F. Oswald.—From the Victoria Nyanza to the Kisii Highlands.

Mr. H. M. Cadell.—The Development of some Scottish Rivers.

Mr. A. H. Garstang, F.R.S.—Some Canons of the Cevennes.

Dr. J. W. Spencer.—Submarine Canon of the Hudson River.

Dr. W. S. Bruce.—The Antarctic Continent.

Mr. E. A. Martin.—Dew-Ponds and Mist-Ponds.

IV.—Index Generum et Specierum Animalium.[1]

Final Report of the Committee, consisting of Dr. Henry Woodward (Chairman), Dr. F. A. Bather (Secretary), Dr. W. T. Calman, Dr. W. Evans Hoyle, the Hon. Walter Rothschild, Dr. P. L. Sclater, the Rev. T. R. R. Stebbing, and Lord Walsingham.

During the year 1911-12 work on this *Index* has proceeded steadily, and a large number of volumes has passed through the hands of Mr. C. Davies Sherborn.

Huëbner's entomological works have been thoroughly examined, and the results of the researches of many workers have been embodied in a paper by Sherborn & Prout in the *Annals and Magazine of Natural History* for January, 1912. All the books of Fallén and Fabricius have been indexed, as also those of Fischer von Waldheim and John Fleming.

[1] Read before the British Association, Sections C (Geology) and D (Zoology), Dundee, September, 1912.

with many others. Increased cabinet accommodation has been necessary, and this has been, as before, provided at the Natural History Museum by the Keeper of the Geological Department.

As regards the continuation of the work, the Committee has great pleasure in reporting that the Trustees of the British Museum have included the compilation of the *Index Animalium* in the General Library Service of the British Museum (Natural History). It has thus become an official undertaking, and Mr. Sherborn will rank as 'Special Assistant' on the staff. This is most gratifying to all parties concerned, for it ensures the safety and completion of the manuscripts which have accumulated during the past twenty-two years. There are now some 664,000 slips, representing 332,000 entries in duplicate, and a great mass of manuscript notes on the dates of books which have passed or will pass through the compiler's hands. Much of this has been printed separately or been included in the official catalogue of the libraries of the British Museum (Natural History).

All manuscripts and documents connected with the work have been handed over by the Committee to the Trustees of the British Museum for preservation in the Natural History Museum, where they may be seen, on application during official hours, by those interested.

In making this final report the Committee desires to express its own and Mr. Sherborn's sincere thanks, not only to the Trustees of the British Museum for their past and present help but also to those Societies that have from time to time aided the work with pecuniary grants—namely, the Royal Society and the Zoological Society of London. Above all, those thanks are due to the British Association for the consistent way in which it has supported the undertaking for the past twenty years, support which alone made possible the successful termination of the first part (1758–1800). The Association will doubtless join the Committee in renewing its thanks to the Syndics of the Cambridge University Press for their generosity in printing and publishing this part. It was issued in October, 1902, as a handsome octavo volume of 1,255 pages, containing 61,600 entries, at the price of 25*s*. On the value of that volume to the zoologist there is no need to insist here; it has spoken for itself to everyone who has taken the trouble to consult it. The manuscript of the second part (1801–50) is well advanced, and will now proceed safely towards completion under new auspices.

Your Committee cannot cease its connexion with this important work without an expression of gratitude to Mr. Davies Sherborn for his devoted labours in the past, and of confidence in his energy to carry to a conclusion the second part of the *Index Animalium*.

V.—Palæobotany *versus* Stratigraphy in New Brunswick.[1] By Marie C. Stopes, D.Sc., Ph.D., F.L.S.

Outline of the controversy, which dates from 1866. The so-called 'Fern Ledges' near St. John, New Brunswick, have a rich fossil flora, but almost no animal remains. Sir W. Dawson described the plants as Devonian. Confusion still exists owing to the mixture of true Devonian plants from Gaspé, etc., in the same monograph of Dawson's. Recent attempts include the beds in the Silurian, for 'stratigraphic' reasons. The necessity of field work as well as palæontological determinations. The author's work in the field; notes on relative dips of the beds, the so-called 'slates', intrusive rocks, and contortions. Observations indicate existence of considerable overthrust. Palæobotanical data. Re-determination of supposed 'unique' species. Type-specimens lent by the Canadian museums and brought to London

[1] Abstract of papers read before the British Association, Section C (Geology), Dundee, September, 1912.

and Paris for comparison with standard collections, resulting in identification of a large proportion of well-known European types in the 'Fern Ledges' flora, all Carboniferous and mostly typical of Westphalian division in Coal-measures. Note the value of fossil plants, as the Carboniferous age of the beds was recognized by Geinitz in 1866 from a single specimen of a fern leaf. The author did the work for the Canadian Geological Survey, to the kindness of whose Director is due the permission to give this résumé of the results.

VI.—The Fossil Flora of the Pettycur Limestone in relation to Botanical Evolution.[1] By W. T. Gordon, M.A., B.A., D.Sc.

THE oldest flora of which we have considerable knowledge is that represented in Upper Devonian rocks, but the plants obtained from Lower Carboniferous strata do not differ markedly from the Devonian types, and so may be included in the Devonian flora. Examples of petrified plants of Lower Carboniferous age have been recorded from several localities in Scotland, but they are nowhere so abundant as at Pettycur, near Kinghorn, Fife. The flora of the Pettycur Limestone, then, has a double interest; the remains constitute fragments of the oldest known flora, and, as they are petrified, the internal structure of these plants may be studied.

Although the Devonian flora is very distinct from that of the succeeding Permo-Carboniferous epoch, yet the organization does not indicate that the plants were primitive. Indeed, all one can say is that the assemblage, as a whole, appears to be less highly specialized than that represented in Upper Carboniferous strata.

As the horizon of the Pettycur rocks is rather high in the Calciferous Sandstone Series, we would expect to find some species whose structure indicated a transition between Devonian and Upper Carboniferous forms. In some cases I believe that such specimens have been discovered. For example, we find several genera belonging to one order, or several species to the one genus, and in such cases one form is more generalized in structure than the others, while the less generalized forms appear to be more closely allied to Upper Carboniferous types.

Among the *Lepidodendra*, for instance, *Lepidodendron Pettycurense*, Kidston, has a perfectly solid central axis; the xylem cylinder in *Lepidophloios Scottii*, Gordon, is occasionally solid in places, but at other parts of the same specimen a mixed pith, consisting of parenchyma and short tracheides, may be noted. *Lepidodendron Veltheimianum*, Sternb., on the other hand, has a well-marked parenchymatous pith containing no tracheides. A line of development is thus suggested by this series, and when we turn to the Coal-measure flora a parallel series may be shown. The lowest member among the Upper Carboniferous *Lepidodendra* has a mixed pith, and hence we conclude that the Pettycur plants show less specialization than those of a later date, though the organization is similar in each case. Such parallel series may also be demonstrated in other groups, particularly among the ferns and Pteridosperms.

The various reproductive members met with at Pettycur also exhibit certain peculiarities. The most complex cryptogamic cone yet discovered—*Cheirostrobus Pettycurensis*, Scott—was recorded from this locality. Certain characteristics common to several groups are combined in the cone, which is thus both complex and generalized.

In the megaspore of *Lepidodendron Veltheimianum*, Sternb., the archegonium has been recorded, and it does not differ from that of the living *Selaginella* or *Isoëtes*.

[1] Abstract of paper read before the British Association, Section C (Geology), Dundee, September, 1912.

To sum up, then, the flora represented in the Pettycur Limestone appears, on the whole, to contain more generalized and simpler types than occur in the Coal-measure and later strata, and these types may be arranged in order so as to suggest certain possible lines of evolution.

VII.—On the Nature of *Parka decipiens*.[1] By Archibald W. R. Don, B.A.

THIS paper was the outcome of an attempted re-investigation of *Parka*, chiefly microscopical, with the aid of Schultz's solution (strong nitric acid and potassium chlorate). Being the only common and quite the most characteristic fossil of the Lower Old Red Sandstone of the Kincardine-Forfar-Perth area, it has naturally attracted considerable attention. The nature of *Parka* has been a subject of speculation ever since its discovery at Parkhill in 1831 by Dr. Fleming. He described it as probably allied to *Juncus* or *Sparganium*, and Hugh Miller, on the whole, agreed as to its vegetable nature. Mantell stoutly maintained it to be 'batrachian eggs'. Lyell thought it the egg-packet of *Pterygotus*, and this determination was accepted by Salter, Woodward, Powrie, and others. In 1890, however, Messrs. Reid, Graham, and Macnair, having convinced themselves of its vegetable nature, sent specimens to Sir W. Dawson, who, with Professor Penhallow, submitted it to a microscopical examination. They clearly showed it to be vegetable, and after boiling it in nitric acid, demonstrated the presence of spores within the carbonized tissue.

The conclusions, other than this main one, arrived at by former investigators have not as yet been confirmed by the present re-examination, the chief results of which, therefore, tend unfortunately to be more destructive than constructive. Hitherto no evidence for heterospory has appeared. The 'prothalli' have not been found. The mode of attachment and other vegetative features have not been elucidated, and an agnostic attitude is assumed, pending further discoveries, with regard to those formerly attributed to *Parka*. No evidence has appeared with regard to the supposed varieties '*media*' and '*minor*'. An attempt, admittedly tentative, has been made to form some conception of the original structure and shape of *Parka*, based on examination of certain excellently preserved impressions of its two surfaces. The main conclusion is that the original spore-containing tissue was almost flat, not spherical (and made up of numerous adjacent lens-shaped spore-sacs)—a structure, in fact, in no way comparable to anything Hydropteridian, and unlike any known sporangia of to-day. There was, certainly, intimately connected with it a so-called 'indusium'. Such a reconstruction must, however, be understood to be hypothetical, and not an ascertained fact. Certain cell-layers and tissues revealed by the more gentle action of the Schultz's solution may, however, help towards an ultimate solution of the perennial problem of *Parka decipiens*.

VIII.—Discovery of Fossils in the Boundary Fault Series, near Aberfoyle.[1] By T. J. Jehu, M.A., M.D.

THIS Series is well exposed between Loch Lomond and Callander, forming a narrow belt separated by a reversed fault from the Lower Old Red Sandstone on the south-east, and probably by a line of thrust from the Leny Grits on the north-west. It consists of black and grey shales, cherts, grits, and calcareous beds, with which are associated some altered igneous rocks. Adjoining the crushed and veined rock which runs along the boundary of the Lower Old Red Sandstone, patches of sheared serpentine are seen at several places, sometimes

[1] Abstract of paper read before the British Association, Section C (Geology), Dundee, September, 1912.

associated with a coarse basic igneous rock somewhat brecciated, as at Maol Ruadh. These probably represent igneous intrusions. Near Loch Lomond grits only are exposed. At the north-east end, near Callander, the belt consists largely of grits, but at Kilmahog quarry there is a good exposure of black shales with an interbedded limestone identical in character with the limestone in the Margie Series described by Mr. G. Barrow (Q.J.G.S., 1901).

The belt in the Aberfoyle area emerges from under the Upper Old Red Sandstone north of Gualann and extends north-eastwards to a mile north-east of Aberfoyle. Widest near Gualann—about half a mile. General strike of beds north-east and south-west; general dip north-west, at high angles. Beds often isoclinally folded along crush-planes striking north-east and south-west. Apparent order of succession from below upwards near Kelty Water: (1) Hornblendic and chloritic schists, probably representing intrusive sheets; (2) thin band of chert and black shale, only traceable for about a mile; (3) band of grit which as traced to north-east comes to abut against Lower Old Red crush rock; (4) thicker band of black shales and cherts; (5) Grit. The Leny Grit follows on the north-west, but at other places it appears to come directly on the black shales and cherts.

Difficulty in distinguishing the grits of the Boundary Fault Series from the Leny Grits. The latter are generally greenish, the former greyish and weathering yellowish-brown, and are peculiar in containing fragments of black shale, chert, and vesicular volcanic matter. Lumps and courses of a very dark grit also occur in the black shales. The shales are usually black, carbonaceous, staining the fingers; generally very crushed. The cherts are pale grey to dark in colour, often finely banded with frequent interleaves of black shale. Joints and veins at right angles to the bedding often numerous. Thin cherty bands and nodules often seen in the shales. Some of the rocks are a crushed mass of black shale and cherty material. The beds are often distinctly brecciated.

Remains of Radiolaria discovered by Dr. Peach some years ago in cherts near Gualann. Recently a number of fossils have been found in pale-grey chert bands, 1 to 3 inches thick, in an exposure on the south-east side of the Bofrishlie Burn, about 400 yards north-west of Arndrum. The fossils occur in muddy films in the chert. Belt here only 300 to 350 feet wide. Some of the shales and cherts are thrust over the disrupted edges of the bands which have yielded fossils. A little north-west the cherts are brecciated, and courses of grit occur in the black shales, also showing signs of brecciation. Some calcareous bands occur in the shales in the bed of the stream. The fossils are almost all hingeless Brachiopods, and the following forms have been determined by Dr. Peach:—

Acrotreta sp., *Lingulella* sp., ? *Obolus* sp., *Obolella* sp., also the flattened chetæ of Polychæte worms.

The fossils indicate that the series is probably of Upper Cambrian age.

IX.—On the Origin of some of the Mica-schists of Anglesey.[1] By Edward Greenly.

In the south-east and centre of Anglesey extensive tracts of country are occupied by mica-schists in which it is a very rare thing to find any survival of the original structures. They are holocrystalline rocks, usually with strong parallel structure, and composed essentially of quartz, alkali-felspars, and a white mica. In certain compact varieties, however, especially about Y Graig, Holland Arms, traces of felsitic texture can be found. Dr. Teall, who has examined the rocks in the field as well as under the microscope, regards them as in all

[1] Abstract of paper read before the British Association, Section C (Geology), Dundee, September, 1912.

probability broken down and partially reconstructed porphyritic felsites, and considers that some lenticular aggregates which they contain may be looked upon as broken-down porphyritic felspars. Twenty-five years ago Dr. Callaway recognized the felsitic origin of these rocks, and the present investigations fully confirm that conclusion.[1] Similar structures have now been found in the rocks of the central area, on its western coast near Trecastell. These schists, therefore, may be looked upon in general as derived from acid igneous rocks. In other parts of both areas, however, mica-schists in continuity with them are found in intimate relations to schists of sedimentary origin, so that it is probable that pyroclastic material was present in the original igneous series.

X.—The Older Granite in Lower Dee-side.[2] By G. Barrow, F.G.S.

A BRIEF description was given of the mode of occurrence and composition of one of the older Granite intrusions in Lower Dee-side. In place of forming large coherent masses it tends rather to minute subdivision, permeating the crystalline gneisses over large areas. Excellent examples of *lit-par-lit* intrusion may be seen on the north side of the Dee, about, and west of, Banchory. The granitic material in these cases forms minute sills, varying from an inch to several feet thick, and almost rigidly parallel to the foliation of the associated gneiss into which it has been intruded. The ground here is comparatively flat, and the method of feeding the sills cannot be clearly made out. But on the opposite or south side of the river the ground is much steeper, and in the hill-faces dyke-like intrusions can be seen, from which the sills proceed. They commence a little below the crest of the dyke, where they are smallest and shortest; they are seen to become steadily thicker and longer as we descend further below the crest of the dyke. In the interior of the latter the granite is usually grey, and contains more biotite than muscovite; oligoclase is also usually abundant; the oligoclase and biotite steadily diminish in amount as the rock is traced towards the taper end of the sills. At this point there is little oligoclase, and often no biotite; muscovite is fairly common, often in large crystals, and the bulk of the felspar is of alkaline composition. It appears that the fissures in which the dykes occur were filled with igneous material, and that under great pressure the walls were burst open and the still liquid material forced out, and thus separated from that which had already segregated out. The phenomenon may be described as magmatic differentiation intensified by dynamic action. Further, the material (pegmatite) which occurs on the extreme ends of the sills is often far coarser than that met with in the centre of the dyke; the distribution of coarse and fine material being thus the reverse of that usually met with in small intrusions.

This separation of the more acid and less acid material occurs in connexion with every dyke and sill over the entire Dee-side area between Banchory and Aberdeen; the pegmatitic material forming a fringing margin, the breadth of which varies considerably. The largest of the sill-like masses occurs at Aberdeen, and part of the city is built on it; its great fringe of pegmatite veins is well displayed on the banks of the Dee near the railway bridge.

The separation of the material rich in oligoclase and biotite from that richer in alkali-felspar and muscovite is not confined to each separate intrusion; it holds good for the intrusion as a whole. Well to the south of the Dee, especially nearer the coast, nearly the whole of the intrusions are more alkaline than those nearer the Dee; the

[1] See Brit. Assoc. Report, Manchester, 1887; also Q.J.G.S., 1897 and 1902.

[2] Abstract of paper read before the British Association, Section C (Geology), Dundee, September, 1912.

pegmatite remains of much the same composition, but there is a considerable amount of schorl present in the southern area that is distinctly rare in the northern.

There is considerable variation in the amount of foliation shown by these intrusions. In the moderate-sized or larger ones the centre is usually unfoliated, or but slightly so ; towards the margins the foliation is more marked. The pegmatite fringe is rarely foliated if it occurs as veins or dykes ; but it usually is more or less foliated if in thin sills. The foliation over most of the area is protoplastic ; post-consolidation crushing is rare. Indeed, it is only well seen in one case, where the granite has reached the present surface far south of the main series of intrusions, and within a lower temperature zone. This intrusion is cut open by a branch of the Cowie Water, close to the Stonehaven Road from Banchory.

XI.—On a Fossiliferous Tufa occurring beneath Chalky Boulder-clay at Launde, Leicestershire.[1] By A. R. Horwood.

In the Report on Erratic Blocks of the British Isles, presented at the Winnipeg Meeting, 1909 (Report B.A., 1909, p. 176), I mentioned the occurrence of a large boulder of tufa found by the side of a stream, the River Chater, at Launde, Leicestershire. At the time I had no doubt the rock was an erratic.

Since then Mr. A. J. S. Cannon has brought me a specimen of the same rock containing land-shells, which he informed me he had found in situ in the same locality. Recognizing the importance of this discovery I accompanied him later to examine the section, with the result that this rock was found in two different places a quarter of a mile apart.

At the first point a section is exposed in the stream-side as follows :—

	ft.	in.
1. Soil	0	6
2. Chalky Boulder-clay, sand and gravel, with Jurassic fossils	*c.* 2	0
3. Calcareous tufa, with plants and land-shells, also *Pisidium*, Entomostraca	0	6
4. Peat, with plant-remains and shells	1	0
5. Tufa, similar to 3	0	6
6. Inclined *margaritatus* shales (Middle Lias)	3	0
	7	6

The disturbed character of the basal beds has no connexion with beds 1 to 5, which are clearly undisturbed, and have not been inverted or thrown out of position since they were deposited.

The importance of this section is evident, for with the exception of a deposit containing plants, Annelids, Crustacea, and Mollusca at Aylestone in the Soar Valley in Holocene deposits, and a similar fauna at Medbourne in the Welland Valley (not yet described), the Launde section is the only ancient one so far discovered in Leicestershire.

In the same district at Launde the tufa was found exposed in ditch-bottoms and rabbit-holes under superficial deposits, some 2,000 feet away. The nearest sections of the same or later age are in Rutland at Apethorp, near Stamford, and at Casewick. I have been favoured by Mr. A. S. Kennard with specimens of the shells collected by J. F. Bentley at Stamford, and described by Professor T. R. Jones, and there is a close similarity between such species as *Helix rotundata*, *Vitrea radiatula*, and *Carychium minimum*, which are the dominant shells at Launde. There are more than twenty species of land and fresh-water shells, besides plants, that remain to be examined. No mammalian remains have been found, nor evidence of the activity of man in this locality.

[1] Abstract of paper read before the British Association, Section C (Geology), Dundee, September, 1912..

XII.—The Discovery of Fossils in the Jasper and Green Schist Series of the Highland Border at Craigeven Bay, Stonehaven. By Robert Campbell, M.A., D.Sc.

BETWEEN Craigeven Bay and Garron Point occurs a series of crushed spilitic lavas with intercalated black shales, jaspers, and cherts. In their lithological characters these resemble closely the green igneous rocks and associated sediments which appear at intervals along the line of the Highland Boundary fault, and which are shown on the Geological Survey maps as of (?) Arenig age. In August, 1909, on the occasion of a visit to Craigeven Bay in company with Dr. B. N. Peach and Dr. W. T. Gordon, we succeeded in finding in the black shales several fossils, including a linguloid shell and a bivalve Phyllocarid Crustacean. The assistance of Mr. D. Tait, of H.M. Geological Survey, was obtained in making a detailed search in the fossiliferous beds. Dr. Peach, to whom the fossils were submitted for determination, has identified the following forms: *Lingulella, Obolella, Acrotreta, Linnarssonia,* and *Siphonotreta*; a bivalve Phyllocarid allied to *Caryocaris* and *Lingulocaris*; and cases of a tubicolar worm. The above genera are most commonly found in the lowest division of the Lower Silurian (Ordovician) system and in the Upper Cambrian. Dr. Peach, while admitting that the exact horizon of the fossils is still a matter of doubt, suggests that, since Graptolites are absent, they are more likely to belong to the Upper Cambrian than to the Ordovician. Whatever may be the ultimate decision as to their stratigraphical horizon the discovery of the above fossils leaves very little doubt that the boundary fault series is *not* pre-Cambrian.

The (?) Upper Cambrian rocks at Craigeven Bay are separated from the Dalradian Schists by a reversed fault, and are overlain unconformably by Upper Silurian (Downtonian) strata.

REVIEWS.

I.—Monograph on the Sub-oceanic Physiography of the North Atlantic Ocean. By Edward Hull, M.A., LL.D., F.R.S. With a chapter on the Sub-oceanic Physical Features off the coast of North America and the West Indian Islands. By Professor Joseph W. W. Spencer, M.A., Ph.D. Folio (18 by 12½ inches); pp. viii, 42, with 11 maps (9 coloured). London: Edward Stanford, Long Acre, W.C., 1912. Price 21*s.* net (post free in United Kingdom 21*s.* 7*d.*).

IN Professor Hull's Atlas of Maps with its accompanying text we have a summary of the author's long-continued observations and deductions concerning the eastern coast of the North Atlantic, and his work is supplemented by that of his friend Professor J. W. Spencer on the Atlantic coast of North America and the West Indian Islands. It brings before the student a collection of facts on submarine coastal features which, if not all new to us, are so ably put forward that they cannot fail to attract the attention of a large class of persons interested in the cartography of the British Islands, especially in their relation to neighbouring lands, of which, at no distant period, they formed a solid part.

[1] Abstract of paper read before the British Association, Section C (Geology), Dundee, September, 1912.

In this atlas Professor Hull gives us a view of those submarine foundations of Britain, stretching out over a wide area around our shores, which were almost certainly dry land, during Pleistocene or early prehistoric times, when these Islands (then continental areas) were inhabited by Palæolithic man and largely covered by forests and vast grassy plains, the home of the mammoth and rhinoceros, its rivers and lakes frequented by the hippopotamus, its pampas-like plains affording abundant pasturage for countless wild horses, herds of red deer and reindeer, bison and elks, which were free to migrate with the seasons, and rove by dry land from Anglia over the continent, from Yorkshire to Brittany, and to cross the valley of the Irish Sea into the then *United* Ireland also; whilst the *Machairodus*, the cave-lion, wolves, bears, and hyænas battened upon the herbivora, and contended with early man for possession of the warmest caves and rock-shelters.

But we are digressing, for the author does not treat of the fauna and flora, but devotes himself specially to the physical features of the then dry land which now forms the 'continental shelf' whereon our Islands rest, and which once was no mean part of Britannia's *dry land*—drained on the west by the Irish River Channel, on the south by the English Channel River, while numerous continental rivers, as the Rhine, the Weser, the Elbe, flowed north, and the Seine, the Loire, Gironde, Adour, and our own Thames all reached the edge of the continental platform far to the south.

Plate i presents us with an outline, on a small scale, of the British Islands and adjacent seas, showing the limits of the continental platform where shallow soundings end and deep water sets in, the margin descending from 200 to 500, to 750, and 1,000 fathoms, or over a mile in depth.

Plate ii on a double page is an orographical map of the British Isles with isobathic contours, and showing the courses of the submerged river valleys as far as the author has been able to trace them by the aid of the soundings furnished by the Admiralty Charts.

Plate iii gives the coast of the English Channel and the Bay of Biscay with all the soundings as shown on the charts and the lower border of the continental platform along the French and English coasts. On this subject it will be remembered that Godwin-Austen brought before the Geological Society an elaborate paper (published in 1850) on the valley of the English Channel, illustrated by a chart.

Plate iv, which is a two-page size map, shows the west coast of Spain and Portugal, the soundings being added.

Plate v, another two-page map, gives the western Mediterranean coasts, Spain, France, and Italy, with Corsica and Sardinia, Sicily, etc., and the submerged land platforms around them like our own Islands.

Plate vi shows the west coast of Africa, and the submerged valley of the Congo extending for 122 miles to the westward.

Plate vii gives us the British Islands during the Lower Glacial epoch, all submerged except the small areas of highlands and the southern portion, together with the narrow chalk barrier between the Straits of Dover then still existing.

Plate viii introduces a map of Norway and its grand series of

fjords, some of which show soundings of 5,000 to 6,000 feet in the central part. That the coasts of Norway have in geological times stood at a very much higher level than at present is shown by the submerged lines and groovings of glacial erosion, which can be traced on the sides of its fjords. There is also evidence of old sea beaches, now greatly *above* the reach of tides, attesting a subsequent re-elevation of the land in later times.

Plate ix shows the physical conditions of the Northern Hemisphere in the Glacial period.

Plate x takes us, under the guidance of Professor J. W. Spencer, to a survey of the submarine valleys along the American coast and thence to the Gulf of Mexico and the submerged valleys and fjords of the West Indies.

In plate xi we are introduced to the submerged valleys of the Arctic basin and Greenland.

In dealing with the mode of formation of the continental platform and accompanying shelf, we have to recognize that the land of the Northern Hemisphere has undergone enormous changes of level in Pliocene and Pleistocene times—changes of elevation and depression and of elevation again; this, in the opinion of the authors, can be abundantly proved by a consideration of the phenomena of the submerged river valleys.

The floor of the shelf was at one time a land surface, as shown by the river channels by which it is traversed, which could never have been carved under the waters of the ocean itself, and the continental slope constituted the coastline of the ocean at various stages of elevation and depression. During this process of terrestrial movement there were doubtless pauses when the surface of the platform was swept by the Atlantic waves; and the continental shelf was the outcome mainly of wave-action and erosion on the one hand, and the action of atmospheric denudation on the other, where the rains, rills, and streams have reduced the coastal plains to levels of no erosion; in either case submerged terraces or platforms result upon the sinking of the land or rise of the ocean level. The continental slope, formed to some extent of terraces hewn out of the rock, as the land rose or fell, assumed its present form somewhat as do the now emergent cliffs on the rock-bound coasts of Norway, Scotland, and Ireland. Such in general terms, writes Professor Hull, appears to have been the process by which the submerged features were formed. It involves a recognition of a great lapse of time, which is difficult for the mind to realize, especially at so recent a stage of the world's history; nevertheless, the evidence appears conclusive that, given the necessary time, these great terrestrial results have been accomplished mainly by wave-action on the lands during periods of elevation and depression, accompanied by occasional pauses giving rise to terraces (p. 5).

Space does not permit us to give a fuller notice of this important work, which furnishes much information beyond the actual scope of the title, although bearing upon the same subject. I recall a MS. map by my father which must have dated back to 1825 or earlier, showing the continental platform and proving how far back the attention of geologists had been drawn to the former connexion of the British

Islands with the continent as proved by the old Admiralty Charts, and the personal knowledge of the coasts gathered by Samuel Woodward, of Norwich, from the fishermen of the North Sea and the captains of ships along the coast. But there is much concerning this subject which has been added to our knowledge in the past 100 years, and such maps as are now produced were unknown in those days. Thus, in the little map published by De la Beche (*Researches in Theoretical Geology*, 1834, p. 190), he showed that "if the British Islands were elevated one hundred fathoms above the level of the ocean, and thus joined to the continent of Europe, they would be surrounded by an extensive area of flat land"; but he then stated (p. 189) that "the soundings round coasts present us with no lines which we might consider to be those of valleys". H. W.

II.—Maryland Geological Survey.

WE have received a copy of vol. ix, dated 1911, of the general reports of this Survey, comprising the third and fourth (final) and summary final reports on State Highway Construction. During a period of twelve years the total road expenditures under the auspices of the State Geological Survey have amounted to more than one and three-quarter million dollars: the work is now carried on under the State Roads Commission. The same volume contains a "Report on the Iron Ores of Maryland", by Mr. J. T. Singewald, jun. The ores consist of magnetite, hematite, limonite (including bog iron ores), and siderite; and the author describes their geological position, extent, and origin. He also gives a history of the Maryland iron industry, with descriptions of the various iron works. The report is well illustrated with maps and photographic views.

Another volume, of 622 pages with 97 plates and 15 text-illustrations, is entitled "Lower Cretaceous", being the fourth of a series dealing with the systematic geology and palæontology of Maryland. The preceding volumes were on the Tertiary and Quaternary deposits. In the present great work the main geological and palæontological features of the Lower Cretaceous are described by Dr. W. Bullock Clark (State Geologist), Mr. A. B. Bibbins, and Mr. E. W. Berry. The system consists of the Potomac Group, which is divided (in ascending order) into the Patuxent, Arundel, and Patapsco Formations. Mr. Berry contributes an account of the Lower Cretaceous Floras of the World and of the Correlation of the Potomac Formations; he also describes the many species of Maryland fossil plants. The fossil vertebrata are dealt with by Mr. R. S. Lull, and the mollusca, which include only *Bythinia*, *Viviparus*, *Cyrena*, and *Unio*, are described by Dr. Clark.

We have further received a memoir on "The Physical Features of Prince George's County", in which the physiography, geology, mineral resources, soils, climate, hydrography, and forests are described. The rocks include small areas of crystalline rocks, gneiss, serpentine, gabbro, and diorite, possibly of Archæan age. The main areas are of Cretaceous, Eocene, Miocene, Pliocene (?), and later deposits. Good illustrations are given of characteristic fossils, and there are instructive views of scenery and geological formations.

III.—Virginia Geological Survey.

BULLETIN No. IV, 1912, consists of a description of "The Physiography and Geology of the Coastal Plain Province of Virginia", by Dr. W. Bullock Clark and Mr. B. Le Roy Miller; with chapters on the Lower Cretaceous, by Mr. E. W. Berry, and on the Economic Geology, by Dr. T. L. Watson, Director of the Survey.

The Coastal Plain, which is bordered by Pre-Cambrian crystalline rocks and by Cambrian, Ordovician, Triassic, and Lower Cretaceous strata, consists mainly of a series of dissected terraces. These are made up of Eocene and Miocene sands, clays, and marls, and of Pleistocene and Recent deposits of sand, clay, peat, and gravel. Particulars are given of the strata and of the geological events which they indicate, the subject being well illustrated by photographic plates and a good colour-printed map. The economic deposits consist mainly of clays; there are also marls, used as natural fertilizers and in the manufacture of cement. A deposit of diatomaceous earth, known as the "Richmond earth", is 30 feet thick in places, and is exposed along the numerous streams close to their crossings from the crystalline rocks on to the sediments of the Coastal Plain. The region in general is an agricultural one with a great variety of soil types, and it is recognized as important "to study in great detail the stratigraphy of the various formations, in order fully to interpret the soils".

IV.—Regional Geology.

THE excellent idea of Professors Steinmann and Wilchens to publish a *Handbuch der Regional Geologie*, which should be issued in separate parts so that geologists can purchase the district they require, is proceeding satisfactorily. Already ten parts have been issued as follows: Denmark, by Ussing (1m. 60); Spain, by R. Douvillé (8m.); Iceland, by Pieturss (1m. 20); Armenia, by Oswald (2m. 80); Persia, by Stahl (2m. 80); Philippines, by Smith (1m. 20); New Zealand, by Marshall (3m. 50); Oceania, by Marshall (1m. 60); Madagascar, by Lemoine (2m. 10); Mid-Atlantic Volcanic Islands, by Gagel (1m. 40). Each part is complete in itself, has maps and sections, gives a full summary of the geology of the area dealt with, and a bibliography. Regional Geology is published in large octavo form by Carl Winter, of Heidelberg, and should prove extremely useful to geologists. The method of publication in areas allows of fresh issues from time to time, each extending and revising the matter dealt with.

V.—Fossil Angiosperms.

Earliest European Angiosperms.—While preparing a catalogue of the Cretaceous plants in the British Museum, Dr. Marie C. Stopes came across three specimens of petrified wood which prove that higher woody Angiosperms existed in this country in Aptian times. These specimens are described in her paper in the Philosophical Transactions of the Royal Society (ser. B, vol. 203, pp. 75–100, pls. vi–viii, 1912), the objects of which are to record the evidence of this important find, to describe botanically the anatomy of the specimens, which belong

to three new genera, and to note their points of structural and phylogenetic interest. Two of the specimens came from the Lower Greensand of Woburn Sands, Bedfordshire, the third from the same formation of probably Luccomb Chine, Isle of Wight; and they are referred to three new genera and species, *Aptiana radiata*, *Woburnia porosa*, and *Sabulia scottii*. These woods show no resemblance to any group of the Gymnosperms, but appear to be like highly-placed Angiosperms; however, no very definite statement can be made as to their affinities, so Dr. Stopes refrains from entering into an elaborate discussion on their bearing on the origin of the Angiosperms. Hitherto it was thought that the Angiosperms in Lower Cretaceous times had not spread eastward farther than Portugal, and the chief interest in the present specimens is their occurrence in Northern Europe in Aptian times.

VI.—Analysis of a Peruvian Lake.

Lake Parinacochas.—Particulars of the composition of the water of this lake have been published by Messrs. G. S. Jamieson and Hiram Bingham (*Amer. Journ. Sci.*, July, 1912, p. 12). Lake Parinacochas is situated in Peru, between 15° and 16° S. latitude and 73° and 74° longitude W. of Greenwich. It is about 150 miles north-west of Arequipa, and about 170 miles south-west of Cuzco. It is fed by small streams, and when visited in 1911 it had no visible outlet. Its elevation is about 11,500 feet above sea-level; its length was about 18 miles, the width 7 miles, and the depth almost uniformly 4½ feet in November, 1911. The composition of the water in milligrams per litre is stated as follows:—

Sodium chloride	9,324·0
,, sulphate	649·3
,, borate	212·4
Potassium sulphate	965·6
,, nitrate	78·0
Calcium sulphate	435·8
,, carbonate	33·8
Magnesium carbonate	342·8
Ferric phosphate	9·3
Silica	8·0
	12,059·0

The salinity is about one-third that of the Atlantic Ocean, and about one-twentieth that of the Great Salt Lake.

VII.—Lower Huronian Fossils.

Canadian Fossils.—Some fossils from the Steeprock Series (Lower Huronian) of Steeprock Lake, north-west of Atikokan, Ontario, have been studied by Dr. Charles D. Walcott, who considers them to be forms related to the Porifera and possessing characters also of the Archæocyathinæ. On this new material the genus *Atikokania* is founded, and two species, *lawsoni* (the genotype) and *irregularis*, are described. The central cavity and radiating tubes of *A. lawsoni* resemble Griffith Taylor's genus *Syringocnema*, and the tube walls

of the former seem also to be perforate. The new genus is distinguished from *Syringocnema* by the presence of irregular septa, and so can be compared with *Pycnoidocyathus* and *Spirocyathus* of Taylor; its mode of growth seems to be essentially the same as that of the Archæocyathinæ. These specimens are described and figured in "Notes on Fossils from Limestone of Steeprock Lake, Ontario" (Appendix to Memoir No. 28, Geol. Survey Canada, 1912).

VIII.—Brief Notices.

1. Meteoric Stone from Kansas.—A second meteoric stone has been found in Scott County, Kansas, and this forms the subject of a paper by Dr. George P. Merrill (Proc. U.S. National Museum, No. 1905, vol. xlii, pp. 295–6, with pl. xxxix, 1912). It is a wedge-shaped fragment weighing 1,900 grams, and it has a fracture so recent that it is scarcely coated by a fused crust. The specimen, which is to be known as the Scott City stone, is chondritic, and the microscopic chondrules are of the usual olivine-pyroxene type, but nothing that could be with certainty identified as a felspar was observed.

2. Waverlyan Period of Tennessee.—The formations that are grouped under this period are in ascending order the Chattanooga, Kinderhookian, and Osagian, and they belong to the lower part of the sub-Carboniferous or Mississippian strata. The palæontological and stratigraphical relations of the formations are discussed by Mr. Ray S. Bassler (Proc. U.S. Nat. Mus., xli, p. 209, 1911).

3. Variscite from Utah.—In the same Proceedings (1912, p. 413) Mr. W. T. Schaller describes specimens of well-crystallized variscite from near Lucin in Utah. The mineral is found in a hard brecciated cherty or chalcedonic quartz-rock, which contains inclusions of nodules and streaks of limestone. It is a hydrous aluminium phosphate with traces of vanadium, chromium, and iron oxides, and it occurs in balls, nodules, and irregular masses in the chert. In colour the variscite ranges from a very pale green to a bright grass green. Gems are cut from it for pendants, brooches, pins, etc., but the stones are not adapted for rough wear.

4. Mining in South Australia.—A review of mining operations in South Australia during the half-year ended December 31, 1911, has been compiled by Mr. Lionel C. E. Gee, Chief Registrar of the Department of Mines. The mining operations, in order of importance, relate to copper, gold, salt, silver-lead, and other minerals, including phosphate, gypsum, pyrites, hæmatite, wolfram, and uranium-ore.

MISCELLANEOUS.

The Great Flood at Norwich.

Our readers will have learnt from the newspapers of the great calamity which has befallen the city of Norwich and large areas of Norfolk.

In November, 1878, disastrous floods occurred at Norwich after sixteen continuously rainy days, with some snow, when 4·50 inches